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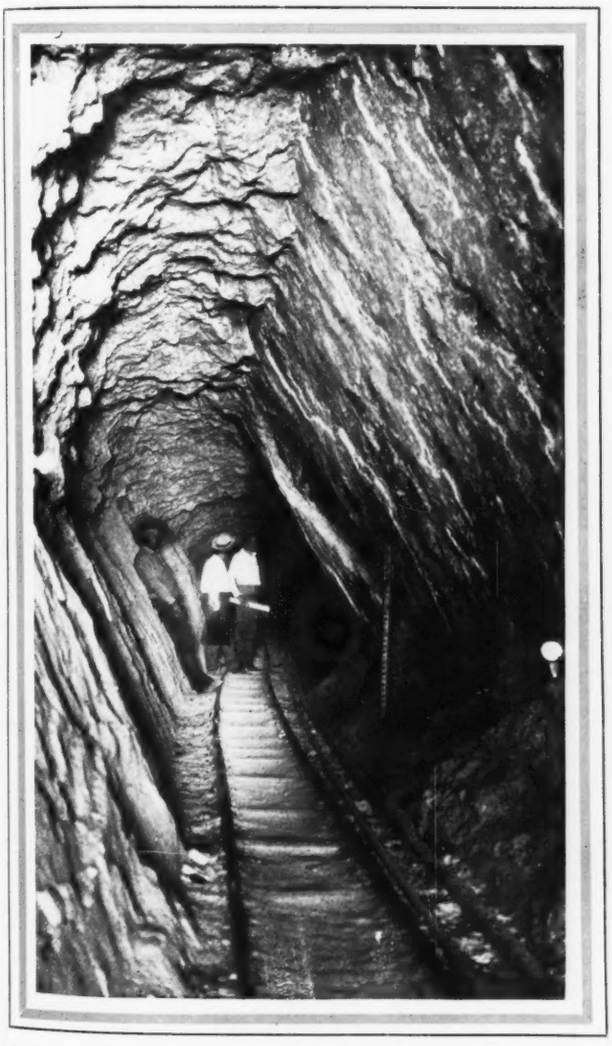


In the Anniversary borax mine, Nevada, where the Callville Wash deposit is being worked. The ledge of colemanite and the hanging and foot walls are seen

Six-Cent Copper from Calumet & Hecla Tailings Recovering the Waste of Half a Century

By C. H. Benedict

Mining Borax in the Muddy Range, Nevada

Upper Mississippi Lead and Zinc Ores-II

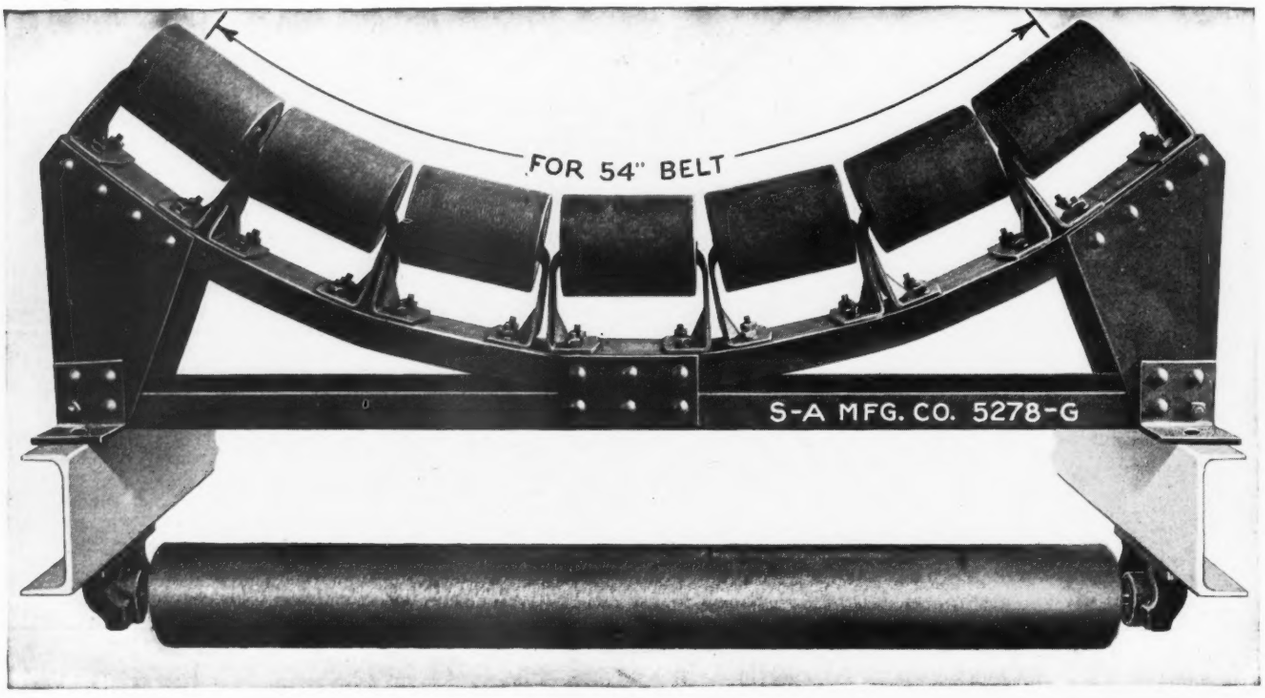
By J. E. Spurr

Engineering and the Human Factor

By Fred H. Rindge, Jr.

A Novel Self-Cleaning Grizzly

Marine and Rail Freight Rates on Metals, Ores and Concentrates



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ENGINEERING & MINING
JOURNAL-PRESS
JOSIAH EDWARD SPURR, Editor

Volume 117 | New York, February 16, 1924 | *Number* 7

Uses of Radio Underground

IT IS INTERESTING to speculate on the possibilities of radio underground. Since the Westinghouse company made its recent successful attempt in New York to pick up local broadcasting stations from a point in a tunnel 80 ft. below the Hudson River, tests have been made in two western mines. For one of these the celebrated Star crosscut now being driven from the bottom of the Hecla shaft in the Coeur d'Alenes was selected. Receiving apparatus set up at a point in the crosscut 6,000 ft. from the shaft, which is 2,000 ft. deep, is reported to have picked up code signals, presumably from a coast station, the messages, however, being too weak to be understood. The sound of the human voice from Bunker Hill & Sullivan's broadcasting station at Kellogg, 20 miles away, was heard, though unintelligibly. Similar tests are reported to have been made at the Junction shaft of the Calumet & Arizona, in Bisbee, where on the 1,400 level what seemed like wireless code was picked up. These results, of course, are too meager to indicate anything. But such tests are interesting and can well be continued, if only to teach us in general the possibilities and limitations of radio.

What value will radio have in mine work? Two uses suggest themselves: for communication between the mine office or other near-by surface points and the underground workings, and, secondly, for communication between two points both of which are underground. In the first case, it may prove an acceptable substitute for the wired mine telephone. In the second, it may have advantages when accidents occur and one part of the mine is cut off from the rest. Several limitations and objections at once suggest themselves. Should ground fall or a fire occur and a group of men be isolated, as happened in the Argonaut mine, radio would be of little value unless the trapped miners could transmit as well as receive. And were such transmission practicable, would the necessary equipment be at hand for the entombed workmen to make use of? How and where would such equipment be disposed of underground ordinarily? These and other questions like them, indicating possibly a varying degree of scepticism, are bound to be asked when the application of radio to mine work is considered, and they must be satisfactorily answered if radio is to be of any assistance when accidents occur. In a play now on the New York stage, thieves and police alike have pocket wireless receivers and transmitters for communicating with their headquarters. Thus imagination solves the difficulty, and it remains for science and engineering to make the idea work. Hence the need for more tests like those in Idaho and Arizona.

"Wired wireless" is another new development in telephony that may offer advantages for mine work. This, or carrier-current communication, is a development of the radio art whereby one may talk between points on a power or electric railway system by using the existing transmission lines with safety as a channel of communication. The transmission line conductors serve as a path along which high-frequency waves are guided, rather than sent broadcast as in ordinary space radio. This applied to mine work would make it unnecessary to install and depend upon ordinary telephone lines in those shafts and tunnels where there are power or lighting circuits.

Whether radio art is already well matured or yet in its infancy is something that time will tell. It is interesting, fascinating and, for many, a gripping hobby. The results of experiments made in mines under difficult conditions can well be brought to the attention of the manufacturer of radio equipment. More than once an enthusiastic amateur has made a valuable contribution to science.

Future of the Bureau of Mines

IT WILL BE A SURPRISE to many to know that one of the chief plans which has been submitted for reorganization of the executive departments in Washington involves the abolition of the Bureau of Mines. The report containing this is a volume published by the Johns Hopkins Press, Baltimore, 1923; it is entitled "Reorganization of the Administrative Branch of the National Government" and was written by Dr. W. F. Willoughby for the Institute of Government Research, which is an organization privately financed for the purpose of studying the conduct of the government's business. The specific recommendation is:

> "ABOLITION OF THE BUREAU OF MINES —The abolition of the Bureau of Mines is recommended since a careful study of its activities shows that there is nothing done by it which cannot be done by other services and particularly by the Bureau of Standards and the Geological Survey. This being so, it is believed to be in the interest of economy and efficiency that it should be discontinued and the duties taken over by the other services that have been mentioned."

Besides the Bureau of Mines, the only other bureau whose abolition is recommended is the Returns Office, which is a dead organization for duplicating records which grew out of the Civil War and has been retained all these years from inertia.

Our readers will of course exclaim that the recommendation is a joke, and it is: but since it is a serious recommendation, it is well to take the joke seriously. Various plans for the Bureau of Mines are now being actively considered. Senator Oddie's plan to create a Department of Mines is the antithesis of Dr. Willoughby's recommendation. Between the two we have the plan of the Cabinet to transfer the Bureau to the Department of Commerce, thus putting it into a separate department from the Geological Survey. There is also a plan, not recently emphasized, to create a subdivision in the Interior Department, headed by an Assistant Secretary of Mines, to administer the Bureau of Mines and the Geological Survey. Our readers should

take a hand in this game and write their Congressmen and Senators as to the plan they favor. It is a necessary duty of citizenship. Our own preference, referring to the foregoing plans, is: 1, the Department of Mines plan; 2, the Assistant Secretary of Mines in the Interior Department plan; 3, the present situation unchanged; 4, the Cabinet plan of transferring the Bureau to the Commerce Department. Dr. Willoughby's plan we would not place on any preference list. Whatever plan you favor, take a hand. You are vitally interested.

Teapot Dome

BY HIS REFUSAL to testify before the Senate Committee on the ground that he might incriminate himself, Ex-Secretary Fall in effect confesses himself at fault, as the previous testimony had indeed proved. The view of his conduct thus left, by default, with the people is not different from that expressed in our editorials of Jan. 13, 1923, over a year ago, and July 14, 1923, long before the Teapot Dome investigations were started. In January we said in part:

"The announcement that Secretary Fall of the Department of the Interior will quit the Cabinet on March 4 is a welcome one. His appointment was not popular; it was purely political. He is essentially a politician rather than a statesman. In the Senate his chief memory is that of a firebrand endeavoring to embroil this country in a war with Mexico by means of misleading propaganda and incendiary speeches. As Secretary of the Interior, his administration of the War Minerals Relief business has been a scandal."

And in July we published this editorial:

"The dispatch from Moscow in the *New York Times* of July 3 that 'H. F. Sinclair, head of the oil company bearing his name, arrived in Moscow today, accompanied by Ex-Secretary Fall, in an advisory capacity,' has astonished many of our readers. Secretary Fall's last important official act was to lease the famous Teapot Dome oil field, in Wyoming, on behalf of the Navy, to the Sinclair interests, an act for which he was much criticized by those who argue in favor of conservation and future preparedness, but which was justified in argument by Secretary Fall's friends. Almost immediately afterward Secretary Fall resigned, and now turns up in Moscow in an advisory capacity to Mr. Sinclair!

"To say the least, Secretary Fall has been indiscreet, and, at the least, obtuse to those appearances of fitness and dignity which are recognized as necessary by the finer type of Americans. Secretary Fall may be politically as chaste as ice and as pure as snow; but he courts unfavorable conclusions with a dull indifference which will not heighten him in the general regard. It is a great pity that President Harding must appoint men of inferior type to even Cabinet positions."

As for the other members of the Cabinet, we feel quite sure that no suspicion of misconduct in this matter applies to any of them. The leasing of the Teapot Dome probably originated in the minds of zealous and patriotic Navy officers, who, unable to secure sufficient appropriations from Congress, saw a way to trade Navy oil reserves for what they felt the Navy and the country required for its immediate protection in the Pacific. Secretary Denby OK'd the plan and Secretary Fall was glad to carry it out. Afterward a few loans and a job from his wealthy friends looked good to the latter; and, having the training of a politician and not a Puritan, he erred. The blame for the Teapot Dome scandal rests not upon Secretary Fall but on the man or men, and upon the political system, which put him into the Cabinet—a man not fitted by dignity and merit for the position, as the country at once recognized. And it is this system, which honeycombs both parties, that is on trial before the people.

Centrifugal Force and Amalgamation

SINCE THE APPEARANCE of the well-known Bazin amalgamator, many years ago, several attempts have been made to utilize centrifugal force as an aid to the recovery of precious metal in ore and concentrate. The underlying idea is a logical point from which research might well start, for it is known that the failure or partial success of amalgamation in some instances is because the metal to be recovered exists in so finely divided a form that it is difficult, if not impossible, to insure contact with mercury by ordinary gravity means. With increasing subdivision, the viscosity of the fluid medium used is such that there is strong resistance to the separation of the heavier from the lighter constituents of the pulp. Thus it is logical that an attempt should be made to supersede the action of gravity, if possible, by that of centrifugal force; but difficulty has been experienced in applying the idea.

The Bazin machine, it will be recalled, consisted essentially of a submerged, revolving bowl, in which the mercury formed a coating against the sides by centrifugal force. It was realized, however, that the depth of pulp was an important factor, the control of which was impracticable, by varying the speed of the bowl or by any other known means. The next step in the development of the fundamental idea was the adoption of double bowls, separated at an adjustable distance from one another. To describe typical operation: The pulp is delivered into the inner, stationary bowl, passes through an aperture around the shaft to the space between the two bowls, the outer one being revolved at a suitable speed. The mercury used for amalgamation purposes is retained in pockets in the revolving bowl, the gold or other precious metal in the ore being thrown by centrifugal force against the mercury and retained there. This describes the features of the Taber amalgamator.

Electricity, from an outside source, has long been recognized as an aid to amalgamation, being particularly valuable for keeping the mercury in an active condition. Bazin realized this in his early researches, but failed in the method of application of the current. Recently, the whole subject of more efficient amalgamation has received the attention of Mr. Russel Thayer, of Philadelphia, who has combined the advantages of centrifugal action and electrolysis in a simple machine of large capacity and extensive amalgamating surface, the development of which will be watched with interest by those who are concerned with the economical recovery of gold from simple ores, or the problem of impoverishing an ore pulp cheaply before cyanidation.

A glance at a curve showing the production of gold in recent years should act as an incentive toward research along lines that promise a reduction of cost, as well as a higher efficiency of metallurgical operation. The possibility of an increase in the output is largely dependent on the application of cheaper methods of extraction or improved recovery per ton of ore. Research on the subject of centrifugal amalgamation, or electrolysis in conjunction with centrifugal amalgamation, has not reached finality, and more attention to this interesting phase of metallurgy will pay.

It is interesting to note that frequent condemnation of the amalgamation process has occurred because of the danger of theft; the volatilization of the mercury during the dressing of the plates has also been blamed as a cause of poisoning. The logical point of attack, however, would appear to be against the method of application, not against the fundamental process. Two

important advantages of centrifugal amalgamation are evident: the compactness and small size of the apparatus necessary, and the ability to protect the amalgam from theft. The mercury is never exposed to the air, except during the removal of the amalgam—an operation that involves no more labor than that required to throw out a switch and open a drain cock. This fact deflects attention to the labor required in an ordinary plate amalgamation plant.

Research of the character being carried out by Mr. Thayer prompts serious thought as to the logic of the customary method of forming a surface of mercury by amalgamating it on bare or silvered copper, an operation which, as is well known, involves considerable labor, not only in initial preparation but also in frequent "dressing" of the surface. Furthermore, the customary method of application of the process has the serious disadvantage that the clean-up, however made, is never complete; and seldom is it possible to estimate the value of the amalgam left on the plate, which, in itself, absorbs the metal. The instantaneous release of all mercury and amalgam, and entrained metal such as platinum, when required, is an attractive feature of the centrifugal method, by which amalgamation of the mercury with the vessel in which the operation is performed is unnecessary.

Proposed Tariff on Copper

THE COPPER-TARIFF SNOWBALL seems to be gathering momentum. Recently the Hancock, Mich., Chamber of Commerce passed a resolution petitioning representatives in Congress to place a duty of 5c. per pound on copper imported into the United States. More recently Mr. Gordon Campbell, president of Calumet & Arizona, made an important statement in advocacy of the copper tariff. The copper producers have as good an argument for tariff protection as many other American industries, and hence are entitled to it if they want it; but granting that a 5c. tariff has been obtained, what are the copper producers going to do with it? It may be worth while to investigate the result of tariff protection on the foreign commerce of the two sister non-ferrous metals—lead and zinc. The lead producers have profited wonderfully by the duty of 2½c. per pound on imported metal; but this is to be expected, as American production is barely large enough to cover domestic requirements, and normally there is no export business in American lead. The lead tariff has separated London and New York prices by about the tariff differential. There is no such separation in zinc, however; in fact, the market for slab zinc in London and on the Continent has at times risen so far above the American market level that it has been profitable to ship domestic zinc to Europe. The tariff on slab zinc importations is 1¾c. per pound, and in 1923 it was about as useful to the producers as a book on evolution to William Jennings Bryan. We will admit, however, that the export of zinc to Europe is abnormal and that ordinarily the tariff might raise domestic prices.

The situation in copper is different. Leaving out 1921, which was such an abnormal year that for a good part of it practically the entire copper mining industry was shut down, net exports of copper from the United States in the last fifteen years have been so large that it has been necessary to use part of the domestic mine production to fill them. If producers are to benefit under tariff protection, the surplus that ordinarily would be shipped to Europe would have to be sold here and would have a tendency to depress domestic prices. The net result would be to level prices in the United States and abroad, nullifying the purpose of the tariff.

We wish to make our position clear. We would favor a tariff on copper if it would raise the price of copper and give the copper industry greater prosperity. This we do not see. We should be glad, however, to receive views on the subject from competent critics.

The Department of Justice

IF IT WERE NOT SO SERIOUS, we should be inclined to laugh at the antics of the Department of Justice, whose ways are indeed beyond the comprehension of the average citizen. Not so very long ago—even now, we imagine—the department was hot on the trail of the grain exchanges, accusing them of depressing the price of wheat and other agricultural products. Still more recently the zealots of the department made a furore over the activities of the New York Sugar and Coffee Exchange and accused that organization of unduly raising prices. The Supreme Court, however, has not supported this governmental effort to stifle the Sugar Exchange, and recently rendered a decision against the Department of Justice, stating that it had produced no evidence to support its claim!

The sad part of the story is that while the Department of Justice has been frightening the trade associations from the collection of harmless statistics and meddling with business generally, one of the greatest scandals in years has developed in Washington without provoking activity of the Department of Justice.

A Chair of Common Sense

ONE OF THE PROJECTS that we have in the future when our income shall have swelled to the point that it bursts our pockets is the endowment of a chair of common sense in one—or more—of our great universities. Considering the tremendous expansion of the sciences and the arts, it has always occurred to us that the most glaring defect in the accomplishments of humanity was the lack of the development of the fine sense of common sense.

To the Ph. Ds. who shall emerge from their future colleges, after having majored in common sense, we shall expect to see referred such problems as the racial antagonisms of Europe, the fiscal policy of France, the revolutionary political system of Mexico, the Fundamentalist-Modernist controversy, the management of the executive departments in Washington, all problems in geology, the dispute about evolution, and so forth, and so on: confident that to the Ph. D. in common sense, all these will be easy. The advanced student in common sense will have to take special sub-courses in the suppression of bigotry, of prejudice, of greed, of jealousy, of hatred, of vanity, of riotous and lawless imagination. When we get a sufficient swing to this movement for common sense, we expect to see the world improve—not before. Who will endow the first chair?

Marine Freights

IN THIS ISSUE, on page 310, will be found for the first time a table of marine freight rates on the non-ferrous metals to important European and Asiatic ports.

Anniversary mine of the West End Chemical Co., a borax producer of southern Nevada

Mining Borax in the Muddy Range

By George J. Young
Associate Editor

THE Callville Wash deposit of colemanite, in southern Nevada, has been described by Hoyt S. Gale[1], and since that time the West End Chemical Co., which acquired the property, has developed the deposit and has installed equipment for its exploitation. Roads have been built and borax mining has been under way at the property for some time.

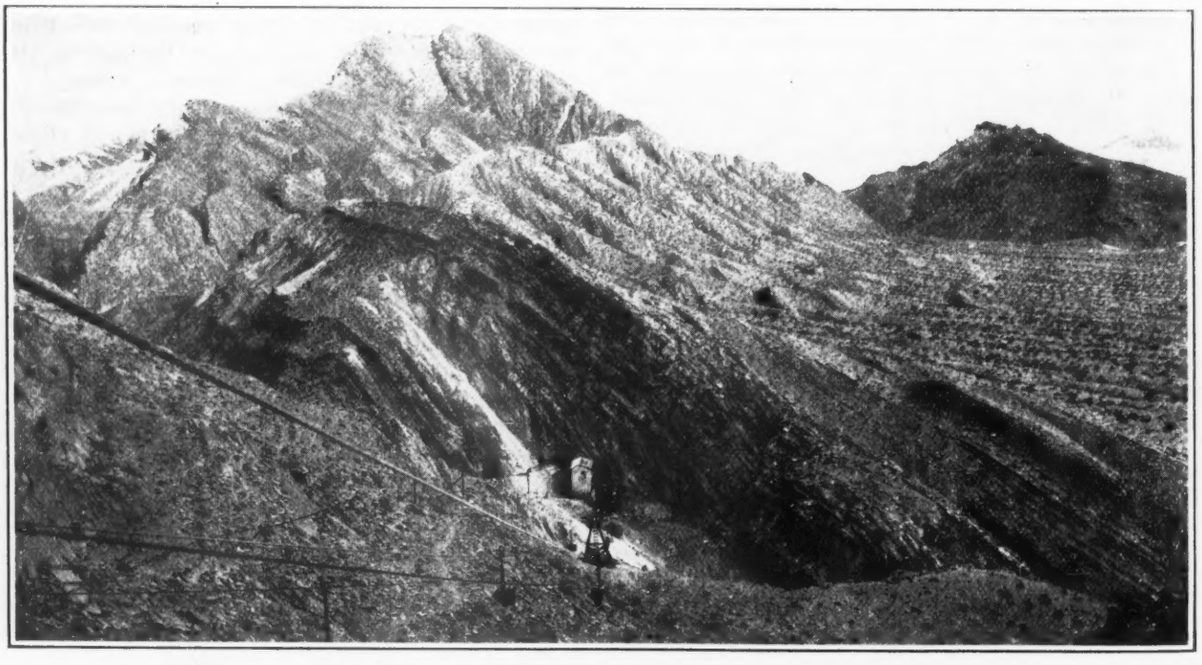
The stoping width in the deposit that is being worked is approximately 15 ft., the dip of the vein ranging from 45 to 55 deg. A modification of shrinkage stoping is employed. The dip of the vein is not quite sufficient for the application of the method to greatest advantage. In addition, the colemanite breaks into tabular pieces, which do not run or slide readily. As a consequence the angle of repose is greatly increased over that experienced with ordinary ores. Where the vein is steep enough, the stopes are kept filled with broken colemanite and the top of the fill is used as a drilling platform. In the flatter portions, as much ore as possible is retained in the stope and small pillars are left at intervals. The final cleaning out of the stopes will be effected by scrapers. It is probable that 90 per cent of the ore will ultimately be recovered.

No timber is used in the stopes, but manways and chutes are constructed of timber after the usual practice. Chutes or mill holes are spaced 20 ft. apart on the levels. The main adit commands sufficient ore, and as a consequence all of the present mining is above this level. It is probable that the level now opened will supply colemanite for many years at the present rate of mining. The ore is trammed from the adit to the loading terminal of an electrically operated wire rope tramway by which it is transported a horizontal distance of 1,200 ft. The receiving bin of the treatment plant is 250 ft. higher in elevation than the portal of the adit. The tramway is automatic, requiring only one man to operate it and fill the buckets.

From the mill bin, the ore is drawn through a crusher and reduced to 1-in. size and is then fed into a 60-ft. rotary kiln. The kiln is 5 ft. in diameter and is oil-fired. Only sufficient heat is used to cause the deflagration of the colemanite crystals. The discharge of the kiln is screened, which separates the clean colemanite from foreign material. The product is transported to the railroad, 26 miles distant, by five-ton autotrucks and trailers. One man can make the trip in a day, taking out ten tons and returning with freight. This has proved cheap and effective.

About fifty men are employed for mining, milling and transportation. The capacity of the present single unit is seventy-five tons of ore per day. Electric power and lighting is provided by a four-cylinder, Fairbanks Y-type oil engine direct-connected to a generator. The fuel used is approximately 27 gravity. Water for plant and camp use is pumped from shallow wells on the property. The present water level is about 40 ft. below the surface. Water for drinking purposes is hauled from the railroad by the trucks.

[1]*E. & M. J.-P.*, Vol. 112, p. 524; Oct. 1, 1921.



Tramway 1,200 ft. long which carries colemanite from mine to kiln for calcining

Six-cent Copper from Calumet & Hecla Tailings

Over 50,000,000 Tons of Sand, Accumulated During Half a Century, Being Treated by Tabling, Flotation, and Leaching

By C. H. Benedict
Metallurgist, Calumet & Hecla Consolidated Copper Co., Lake Linden, Mich.

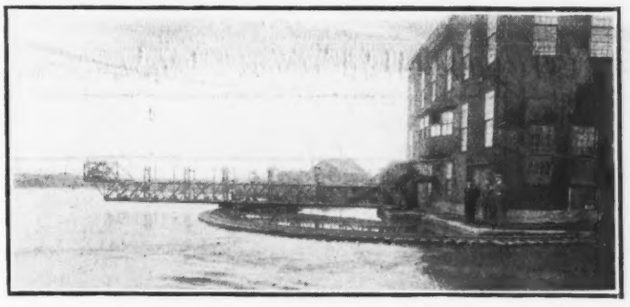
THE CALUMET & HECLA MINING CO. was organized in 1871 as a consolidation of four companies, two of minor importance, together with the Calumet Mining Co., formed in 1865, and the Hecla Mining Co., organized about a year later. Both these latter companies found profitable ground at once and began the erection of stamp mills. The Calumet Mining Co. first erected its mill at the mine, but in a few years moved to its present site on Torch Lake adjoining the site on which the Hecla Mining Co. had already built its original mill and which is about four miles from the mine. These mills have been in existence then, at the same site, for upward of fifty years and have been depositing their tailings continuously into Torch Lake during that period.

Torch Lake is one of a series of inland lakes in the Keweenaw peninsula of upper Michigan, but is distinguished by being on the same level as Lake Superior, with which it has navigable connection; and it is distinguished further by the fact that it is quite deep relative to its area. At the time the mills were erected on the shore of this lake there was no thought of anything except the desire to find room for the sand tailings, but considering the development of the mine and of the art of metallurgy in the fifty years following the foundation of the mills, no better site could have been found anywhere. The shore adjacent to the lake is relatively flat, so that all buildings are at approximately the same level, but the sloping hills running down toward the shore permit of a uniform grade to a gravity railroad, and a trestle of moderate length gives the necessary elevation for gravity run to the ore bins and stamps.

The mills were built close to the shore of Torch Lake, and for some years there was sufficient elevation so

Dredge and portion of pontoon line

that the tailings ran into the lake by gravity, but as the deposit increased in area the shore gradually receded and it was necessary to provide some means of giving the tailing sufficient elevation to reach the lake. For this purpose a device was developed unique in this country at that time, and even yet but few are in use outside of the Lake Superior copper district. This is



Shore plant, showing storage pool and swinging suction line

known as a sand wheel, a slowly revolving wheel with depressions or buckets in the periphery which take their load at the bottom and discharge tangentially on approaching the top. Starting with a 30-ft. wheel the diameter of successive wheels was increased to 40, then to 50, and finally to 65 ft., to reach the desired elevation.

Originally two mills were built, known as the Calumet mill and the Hecla mill, and there are two distinct tailing piles with their centers about three-quarters of a mile apart and with clear water between, the two almost inclosing a bay from which is drawn the water for the pumping station. These tailing piles covered an area of about 152 acres at one time and vary in depth from nothing at the shore line to 120 ft. The reclamation plants are erected centrally to the north of the Calumet pile, and it is this pile that is now being reclaimed. The Hecla bank was all of it conglomerate up to about 1900, but since that date the south or extreme end has been mostly amygdaloid tailings of much lower grade, and there will be a boundary line between the conglomerate and the amygdaloid, which, as dredged, will be a mixture of the two. When this mixed material is to be reclaimed it will result either in the inclusion of low-grade material which would not pay by itself to reclaim or in the exclusion of some conglomerate tailing which by itself would be profitable.

At the beginning of mining operations in the late 60's the ore was running better than 100 lb. to the ton by assay and the metallurgical methods were naturally crude compared to present-day standards. The ore increased in richness for some years after the opening of the mines, and tailing losses of 20 lb. to the ton and more were not out of the ordinary. In those years the smelters required a very high-grade product, and as the fine copper could not be concentrated profitably to smelter requirements, practically no effort was made to save the slimes until about 1884, when buddles or circular slime tables were introduced. Neither was any effort made, except spasmodically, to do any grinding other than that by the original stamp, which crushed all material to pass through a ⅞-in. round opening screen. This made for very rich tailings, and it was not until

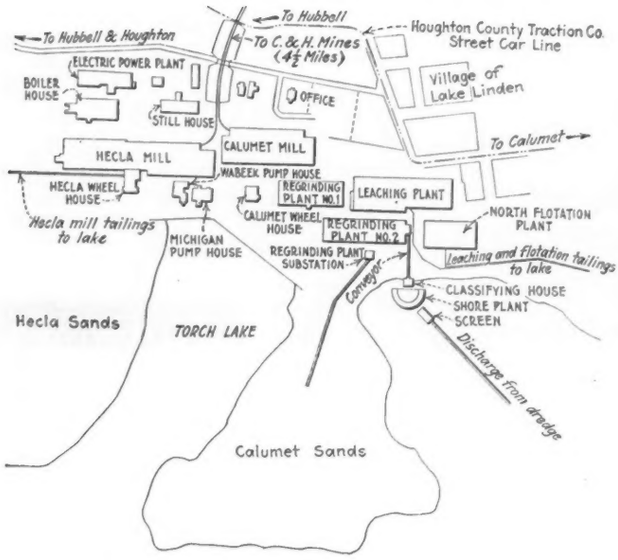


Fig. 1—Map of Calumet & Hecla units at Lake Linden

about 1898, with the introduction of Wilfley tables, soon followed by fine grinding in Chilean and later in Hardinge mills, that any serious attempt was made to reduce the losses of fine inclosed or attached copper. The introduction of this more modern machinery was coincident with a rapid falling off in the quality of the ore sent to the mill, owing partly to the lessening in grade of the deposit underground and partly to the fact that lower-grade ore could be treated economically. A further decided drop in the copper losses followed the installation of a regrinding plant in 1908 and made it appear that the tailings subsequent to that date might not be profitably reworked, although they still contained about 9 lb. of copper to the ton. These tailings were accordingly segregated on one portion of the Calumet pile. With the discovery of the leaching process in 1912 and the adaptation of flotation a few years later it became evident that these apparently worthless tailings were of economic value. In the year just passed the work was almost entirely on these later fine, low-grade tailings, and the curious fact is that while the recovery per ton was less, the cost per pound of copper recovered was as low as on the richer coarse tailings of previous operations. This is because the regrinding cost is entirely eliminated.

That these tailings had commercial possibilities was recognized for a great many years before any effort at recovery was begun. Until the development of modern fine-grinding machinery, coincident as it was in the Lake Superior district with the introduction of the low-pressure turbine and consequent cheap electric power, it was not felt that the time was right for beginning operations. Then, at first, the plans were only for finer grinding and Wilfley table treatment, and it was the expectation that the recovery might not exceed 40 per cent. Even this was attractive, and work was begun in 1912. The regrinding plant was not yet in operation, however, before the leaching process was developed, which promised to double the anticipated recovery. Construction work was started in 1914 on the leaching plant, designed to treat sand, and experimentation was continued on the treatment of the slime by the same process. The rapid development of flotation, however, and its adaptation at the Calumet & Hecla to native copper, made it advisable to discontinue work on the leaching of slime, and a flotation plant was erected for this material. This again increased the recovery, so that about 85 per cent of the values contained in these tailing piles will probably be obtained by the present process. Inasmuch as the recovery on the ore originally was about 75 per cent, over 95 per cent of the metal contents of the Calumet &

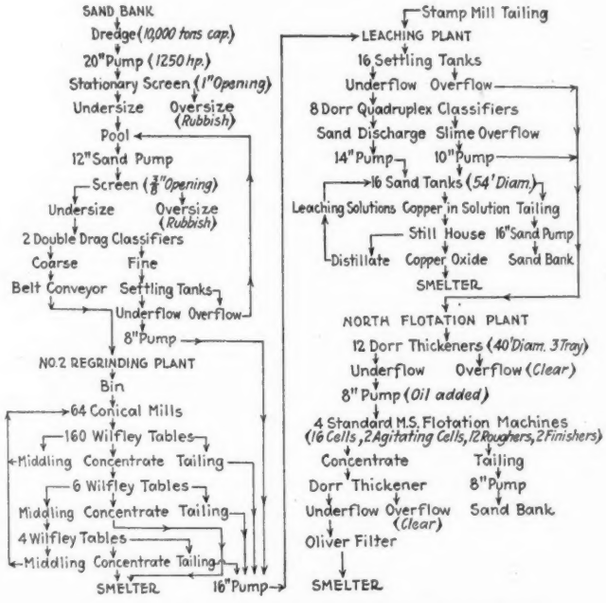
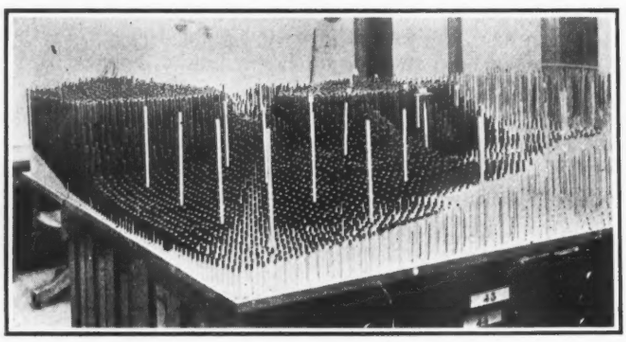


Fig. 2—Flow sheet of reclamation plant



Model showing status of sands for reclamation plant. The white represents lake bottom, and the dark, reclaimable sands.

Hecla conglomerate lode as mined will be obtained as refined copper, a record probably unique in the history of any copper-mining operation.

Although the commercial possibilities of these deposits had been recognized long before recovery plants were erected, their treatment was not sufficiently imminent to prevent surface contamination. All the rubbish of the stamp mills and from the adjacent towns was deposited on top of these sand banks, and although this rubbish does not constitute a large percentage of the total weight, it amounts to thousands of tons of every conceivable kind and size of material, and any plan for the reworking of the sand had to take into account a mixture of ashes, hoop iron, wire cable, launder plates, and submerged logs. After five years of operation the suction dredge originally chosen has been in commission without at any time having had serious difficulty in operation.

The reclamation plant as at present constituted consists of five units separately housed as follows:

1. Dredge.
2. Shore pumping plant and classifying house.
3. Regrinding plant.
4. Leaching and distillation plant.
5. Flotation plant.

Fig. 1 shows a diagram of the units of this plant in connection with the other mill buildings. Fig. 2 is a flow sheet.

1. *Dredge*—It was recognized at once that a suction dredge would be the only possible means of reclaiming these tailings, because of the depth of the deposit and the severity of the climate. It was not feasible to develop a dredge by experimentation on a small scale, because from the very nature of the problem large-scale operation only was possible. No dredge had ever been designed to dig 110 ft. below the water level. A bucket dredge was considered entirely unfit, because of the depth, and also because of the fact that although a bucket dredge might handle rubbish to good advantage, the sharp coarse sand would be very hard upon the innumerable bearings. Further, it was thought impossible to operate such a dredge in winter time in the Lake Superior district, with the thermometer frequently reaching 20 deg. below zero.

The dredge finally adopted was developed with the aid of the Bucyrus Company, of South Milwaukee. It is a steel-hull dredge 56 ft. wide and 110 ft. long, with an overhanging deck 8 ft. wide. As originally installed, having in mind the amount of oversize rubbish to be handled, the dredge was provided with two dredging pumps. The first discharged into a 1¼-in. revolving screen for removing rubbish, the undersize going to a sump from which a second pump elevated the material and discharged it through the pontoon line.

After experiencing considerable trouble with the elimination of the oversize rubbish in this way, a method was finally devised of using but a single pump for dredging the sand directly from the pile and discharging it through the pontoon line to a stationary screen at the shore plant. This eliminated entirely the revolving screen on the dredge and the second dredge pump, and resulted in a tremendous saving of power and maintenance. It is surprising what large pieces of timber, rope, and even steel plate can be picked up by the pump and carried through 3,000 ft. of the 20-in. discharge pipe to the receiving pool on shore without choking pump or pipe.

In winter time 2 ft. of ice on the lake is usual, 20 deg. below zero is not uncommon, and usually for two to three weeks the temperature is continuously below zero. However, these conditions have caused no delay in the eight years of operation, and the dredge has less difficulty and loss of time in mid-winter than the railroad that brings ore from the mine to the mill. At first, efforts were made to cut the ice from about the dredge and haul it away. When the revolving screen was discontinued, however, so that the second dredging pump was not required, this pump was connected to a pipe surrounding the dredge and discharged water through a series of nozzles about 10 ft. above the deck of the dredge. The agitation from this water was sufficient to keep the ice from forming freely and also to melt such ice as had been formed adjacent to the dredge. For the last four years it has not been necessary to break or remove ice by other means, and the cost of operating this pump for a few hours each day is small.

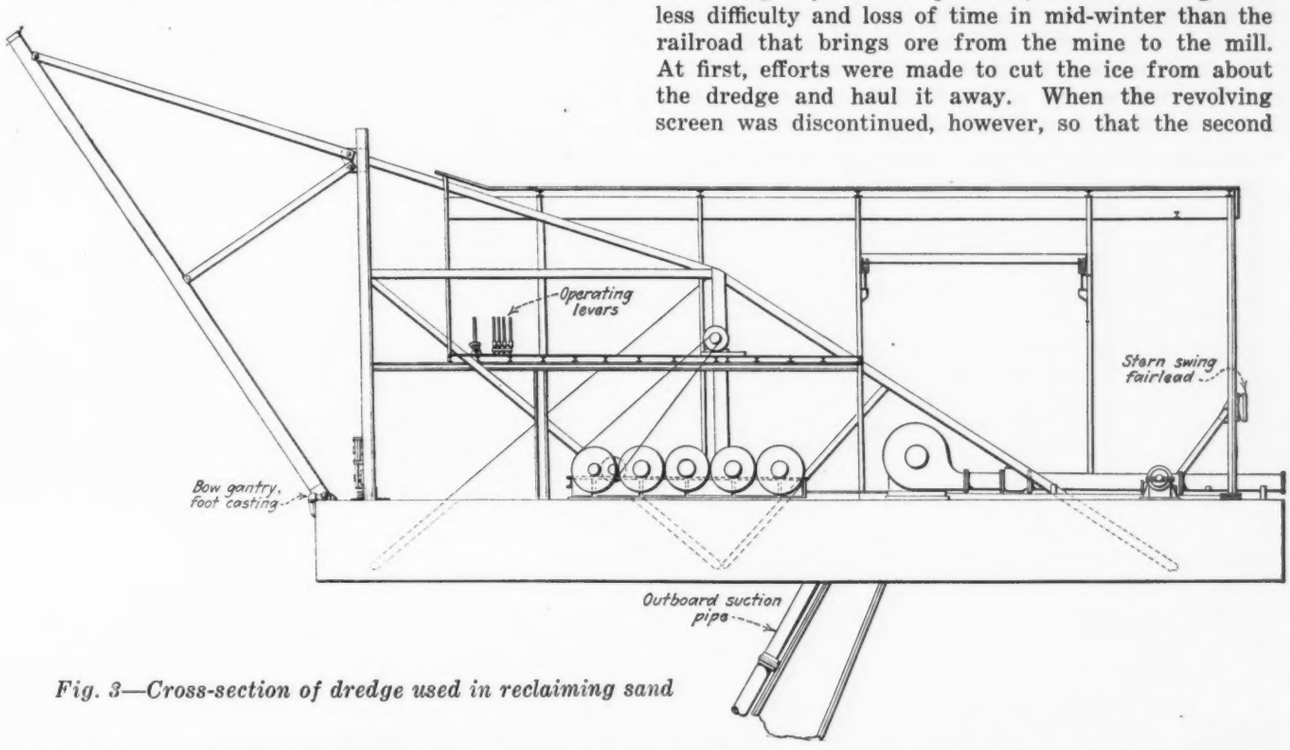
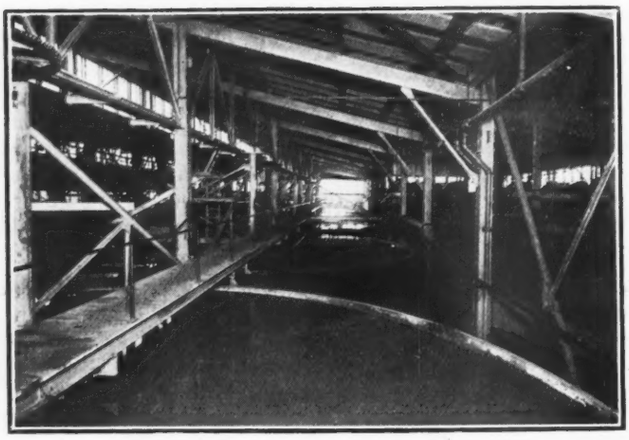


Fig. 3—Cross-section of dredge used in reclaiming sand

Fig. 3 shows a cross-section of this dredge. The dredge pump itself has a 20-in. diameter inlet and outlet, with impellers 55 in. in diameter, operating at 360 r.p.m., and is equipped with a 1,250-hp. motor. The pump casing is split vertically and is lined throughout. Various types of material for liners have been used, and although the best results are obtained with manganese steel, chilled cast iron made in the local foundry is much the cheapest material per ton dredged. In addition to the main dredge pump, and an auxiliary pump for supplying water to prevent ice formation, there is a 4-in. centrifugal pump for service water and an 8-in. centrifugal pump for supplying water at 75-lb. pressure for agitating the sand. The dredge suction is supplied with nozzles reaching out in all directions



Flotation plant, showing row of Dorr thickeners. At *the right are the backs of the flotation machines.*

along the periphery of the suction mouth; these nozzles discharging water under pressure keep the sand in agitation and break down the bank in advance of the digging ladder. The pipe for supplying this water is carried on the digging ladder and connected to its pump through a rubber sleeve. This type of agitation has proved satisfactory and at no time has the lack of a rotary cutter been felt.

When the dredge gets into certain portions of the bank there is a tendency for the material to hold up beyond the natural angle of repose, and consequently caves of considerable magnitude occur. Only once has a cave-in proved serious, the digging ladder being caught under an avalanche of sand. To release it, it was necessary to abandon the regular suction of the dredge and install a new suction, using the original dredge pump, operating the temporary suction independently by means of tackle from above, lowering it gradually through the accumulated sand, and adding additional pipe with depth until the ladder was finally freed. The ten-day delay because of this accident, and a second shutdown of three weeks when the dredge was dry-docked and the hull scraped and painted, have been the only interruptions to continuous service during eight years of operation.

The suction ladder consists of two longitudinal latticed girders thoroughly fastened and well braced. It is 141 ft. from center of suspension to the end of suction, and will permit of dredging to a depth of 110 ft. It carries the outboard suction of lap-welded pipe and also an 8-in. water pipe for supplying water under pressure for breaking down the sand. The center of the dredge pump is on the same center line as the pivot of the suction ladder, and the suction pipe is connected to the pump by an elbow, swiveled on this same center line. Near the outer end of the suction ladder the lower block of the hoisting tackle is attached, and the upper block is attached to the bow gantry, forming part of the hull.

The dredge is not self-propelling, but is operated by swinging lines fastened to anchors in the water and deadmen along the shore. There are two four-drum winches for operating the lines, two drums of which are for the ladder swing, two for the bow-line swing, two for the stern-line swing, one for the stern line, and one for hoisting the suction ladder. The bow swing lines are ¾ in. diameter, the ladder and stern lines are ⅞ in. and the ladder hoist rope is 1 in. diameter, all plow steel. All pumps and winches are electrically driven, but there is a small boiler on the dredge to provide steam for heat and also for operating capstans when the electric power is cut off.

Electricity is supplied to the dredge at 2,300 volts, the power lines being supported on towers attached to the pontoons carrying the discharge pipes. The main dredging pump motor is 1,250 hp. rating and consumes about 900 kw. when working through its maximum discharge pipe of 3,000 ft. length. An additional 200 kw. is consumed by the 8-in. and 4-in. water pumps. Water rheostats control the speed of the pump with a variation of about thirty revolutions, from a minimum of 335 r.p.m.

Inboard and outboard pipe is of 21 in. diameter outside and the discharge line consists of the same kind

Regrinding plant, showing 64 8-ft. x 18-in. Hardinge mills

of pipe, mostly in 60-ft. lengths, carried on steel or wood pontoons. The pontoon pipes are connected by means of rubber sleeves, and although other types of flexible connections have been tried, especially ball joints, everything has been abandoned in favor of the rubber sleeve. The sleeves are held on by split steel bands, which arrangement, in connection with the beaded ends of the pipe, gives a simple flexible joint, and one that does not cause much trouble.

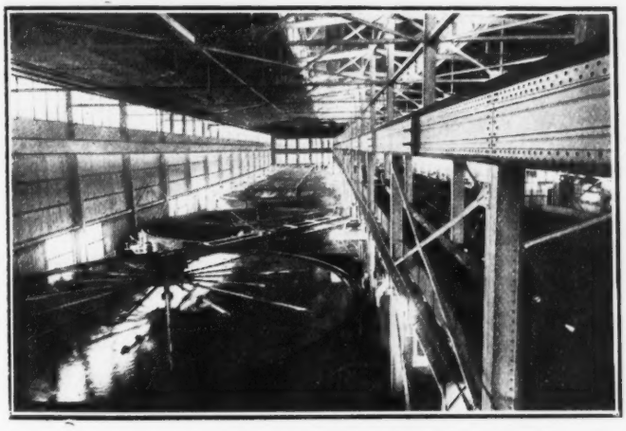
The pontoon line discharges at a fixed point on the shore into a stationary screen 16x20 ft., with round openings 1 in. in diameter. This discharge is placed so that the sand runs from the screen into a pond or reservoir which supplies the pumps in the shore plant about to be described. Not much rubbish accumulates on the screen, but it may consist of large pieces, including many relics of the early days. A chain 6 ft. long was once removed from the screen; also pieces of cast iron, innumerable rocks, and logs up to 16 in. in diameter.

The dredge has a rated capacity of 10,000 cu.yd. per day, which has been realized. No facilities have ever been at hand to make a definite test of its efficiency, and there is so much variation in the size and nature of the sand to be pumped, the length of discharge line, the condition of the impeller and pump casings, and depth of suction, that a test would be of little value. In the winter about sixteen hours, including delays, are required to do the necessary work, and sometimes during the summer, when the pontoon line is 3,000 ft.

long and the sand is fine and scattered, continuous operation is necessary.

No effort is made to synchronize the operation of the dredge with the plants on shore, which must run uniformly twenty-four hours per day. The capacity of the reservoir in front of the shore plant is such that the dredge can shut down two or three days at a time without the plants being short of sand. A dredge is necessarily intermittent in its operation, even when working under the best of conditions, and under the varying conditions met in this operation there is no possibility of supplying sand in either uniform quantity or dilution.

The general method of operating the deposit and the measurement and control of the work is carefully studied from day to day. Fortunately the United States Government had made accurate soundings in Torch Lake before the mills were operating for any length of time, so that the extent of the deposit both laterally and in depth is accurately known. A sectional model (shown in the illustration) has been made, consisting of vertical wooden pegs fastened into a horizontal board representing a base line. These pegs indicate conditions for each 50-ft. station and by means of different colors show lake bottom, lake level, and recoverable sand. Frequent soundings keep this model up to date, and operators on the dredge know at all times at what depth to expect sand and to what extent. Ranges along the shore and floating buoys assure accurate knowledge as to the position of the dredge, and a section of the model in the pilot house provides



Row of tanks in leaching plant. First tank has launder and distributor in place. Second tank is uncovered. Others have covers in place.

complete information as to conditions of deposit. The original lake bottom is fortunately a compact sand that resists dredging with this type of machine, and much of the area is as clear of tailing after dredging as a surface operation could be. In addition to this model, which is changed to show existing conditions, there is a cross-section for every 100 ft. which shows the progress from month to month.

A problem at first was to find room for current tailing. For this reason the outer and more recent deposit has been dredged up to this time. In winter when the climatic conditions are at their worst the dredge is moved close to shore to shorten up the pontoon line and minimize operating difficulties; in summer more distant material is attacked. The operation is from its nature a "one-stope mine," but the quality of the sand does not vary greatly from day to day, although the proportion of coarse to fine does show a wide fluctuation. This results in operating difficulties felt more particularly in the flotation plant.

The cost of this operation for 1923, including all replacements and renewals, was 6.30c. per ton dredged. This is made up roughly of 32 per cent for labor, 14 per cent for pump renewals, 40 per cent for power, and 14 per cent for other supplies. These costs are for an average discharge line of about 2,000 ft., and vary somewhat with the size of sand, length of line, and other factors. The costs are showing a downward tendency from year to year as capacity is being increased and as greater experience is being acquired.

2. *Shore Pump Plant and Classifying House*—This plant is built upon a concrete dock constructed by driving piles through the sand down into the original lake bottom and upon these piles putting a cap of concrete 3 ft. 6 in. thick. The shore plant contains a 12-in. Morris centrifugal pump for the elevation of the sand, stationary screens for removing fine rubbish, drag-belts for separating the coarse sand that requires regrinding, from the fine, pumps for handling this fine sand, and a belt conveyor for conveying the coarser sand from this plant to the top of the regrinding plant. In the pond or reservoir in front of the shore plant into which the dredge sand is discharged is a semicircular row of piles having a radius of 35 ft. on which is constructed a track. Supported on this track and pivoted in front of the plant is a structural steel bridge 55 ft. long, which carries the suction pipe of the pump in the shore plant. This suction pipe works on swivel joints, so that it can travel through an angle of about 150 deg. and its outer or suction end can be raised or lowered vertically through an angle of 90 deg. The effect of this is to get a storage capacity for this suction pump in the shape of a "V" section along about one-half of the circumference of the 55-ft. circle and to a depth of 30 ft. below the water line. Thus is obtained a storage reservoir equivalent to about 20,000 tons' sand capacity, from any part of which the sand may be reclaimed, depending upon the position of the suction pipe carried on this swinging bridge. In reality it is a stationary dredge working under uniform conditions as to length of suction line, so that uniform capacity is obtained and the re-treatment plants are kept operating under uniform conditions, a necessity for efficient metallurgical practice.

To guard against delays in the shore plant, the original design called for two pumps so placed that

Leaching plant, showing tank filling

by swinging a suction elbow through 180 deg., one pump could be replaced by the other. Delays have been so infrequent, however, that such changing of parts as is necessary can be done during the regular six-hour shutdown once a week, so that only a single pump has been necessary. This pump has a 12-in. suction and discharge, is split horizontally and lined throughout. The impeller is 40 in. in diameter, running 375 r.p.m. direct connected to a 200-hp. motor. The discharge of this pump goes into a large receiving box fitted with an overflow for the excess water, and as this water carries considerable fine sand it is returned to the storage pool. Circulation of water is very useful in winter, as the agitation caused thereby aids in keeping the pool free from ice. The receiving box is provided with four openings, gate controlled, through which the sand and water flow to stationary screens with ⅜-in. diameter openings. These screens are for the purpose of removing the finer particles of rubbish. The undersize of these stationary screens is fed to two double drag-classifiers, each fitted with two 20-in. belts, these belts being provided with 6x4-in. angle

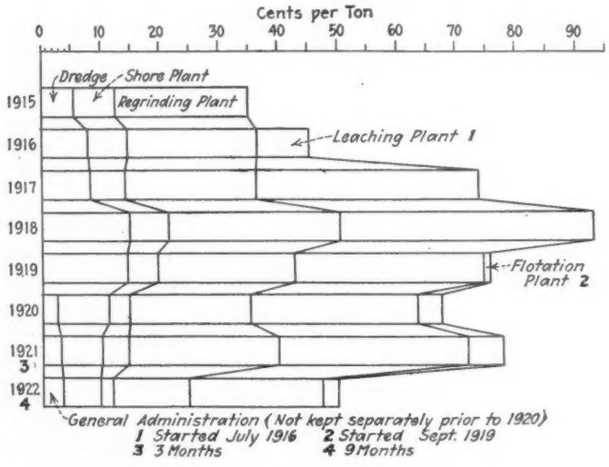


Fig. 4—Reclamation plant costs, 1915 to date

irons, 24 in. long, as drags. The discharged product of these drag belts is fed by chutes to a 22-in. belt conveyor, and the overflow, after suitable dewatering, is pumped directly to the same sand- and slime-classifying system that takes also the tailing of the regrinding plant.

The cost of operation of this plant for 1923 was 2.47c. per ton, including belt conveyor delivery to the regrinding plant. Of this cost 45 per cent was for labor, 30 per cent for power, and 25 per cent for supplies, chiefly pump repair parts and pipe.

3. *Regrinding Plant*—The material treated in the regrinding plant is the coarse sand classified out by the drag-belts in the shore plant and fed to the top of the plant by means of a belt conveyor. This belt conveyor is 275 ft. between centers, runs at a speed of 500 ft. per minute, and has an inclination of 2½ in. to the foot. It discharges into a receiving bin, which has sufficient storage to supply the mills for about thirty minutes. In the bottom of this receiving bin are discharge openings, from which the relatively dry sand is run at a uniform rate and fed by means of water jets into launders running down either side of the plant and discharging into dewatering boxes for feeding the conical mills.

The building itself is 122x431 ft. and contains 64 Hardinge mills, 8 ft. x 18 in., driven individually by 40-hp. motors connected by means of flexible couplings to herringbone pinions driving corresponding herringbone gears. Each mill revolves at 26 r.p.m., is lined with either Belgian silex or domestic quartzite, and uses flint pebbles for the grinding medium. The conical mills were among the first built by by the Hardinge Company and are low in capacity. At a corresponding plant now being built for the Tamarack sand, Hardinge mills are being used as before, but they have a cylindrical length of 6 ft. instead of 18 in., are driven with 100-hp. motors and give about three times the capacity of the shorter mill. These conical mills and motors are carried on a structural steel framework or floor about 12 ft. above the Wilfley table floor. The mills are in two rows of thirty-two each and are served by a fifteen-ton traveling crane which can pick up a full mill. All relining is done at the end of the plant, where piers are provided for this purpose. By the use of two extra mills it is usually possible to take a worn-out mill and replace it within an hour by a newly lined spare.

The mills are fed by a gate in the overhead launder handled by a lever from the conical-mill floor. The material cut out in this manner is run into a dewatering box, from which a plug discharges the thickened product into the feed scoop of the conical mill. The discharge of the mill is run into a distributing launder and fed directly to Wilfley tables, the product of two mills going to five Wilfleys. The concentrates from the Wilfleys are reconcentrated on other tables, and the final concentrate is pumped into elevated bins for dewatering, afterward fed by gravity into concentrate cars. Table middlings are returned to the conical mills for finer grinding. The tailing from the Wilfley tables joins the fine product from the drag-belts in the shore plant, and this combined material is pumped by means of a 16-in. centrifugal pump to a classifying section in the leaching plant where sand for leaching is separated out from the slime for flotation.

Special Considerations Govern Grinding Practice

This regrinding plant has a capacity of about 3,000 tons per twenty-four hours. The capacity per mill is low and the grinding efficiency is not the best, but efforts to improve conditions have not been successful. All grinding is single-pass, which would not seem to be according to best practice, but such experimentation as has been done with closed-circuit grinding on native copper ores, both in this plant and in other sections of the district, has not met with great success. A little thought as to the difference between native copper ore with its flat metallic particles compared to more friable crystalline ores met with in other metallurgical fields will be enlightening. With ordinary ores, in closed-circuit work the particles finally overflow the classifier or pass through a screen of the size adopted and thus are ready for further metallurgical treatment. On native copper ores, however, the very particles which are to be eliminated from the circuit as soon as possible are the ones that resist comminution. The result is that the native copper builds up in the circuit to an alarming extent—so much so, in fact, that the abrasive loss due to the sliming of this concentrated copper becomes a serious question in subsequent treatment, particularly as flotation recovery is not so satisfactory as it might be.

The use of steel liners and balls also comes to mind,

but they have not proved advisable. The conglomerate ore probably resists comminution to a greater extent than any other ore treated in this country. Tests indicating this have been made by various independent investigators, notably Lennox, who found for this ore a "comparative crushing resistance" of 1.33 as against a low of 0.37 on Ray ores and 0.38 on Utah. For this reason consumption of pebbles is large—about five pounds to the ton—and such steel and cast iron balls as have been tried show a loss almost as great. With pebbles delivered at ¾c. a pound, amounting to 4c. per ton of sand crushed, and with steel costing 3½c. per pound, or 14c. per ton of sand crushed, there has never been any inducement to add the necessary equipment for changing over to steel balls in view of an increased operating cost of 10c. per ton.

The cost of operation for this plant, in cents per ton, for 1923 was as follows:

General expense		1.82
Sand conveying and distribution		1.86
Grinding		25.27
Attendance	1.37	
Power	13.63	
Pebbles and lining	9.38	
Other supplies	.89	
Table treatment		4.00
Total		32.95

Metallurgical results for the same year follow:

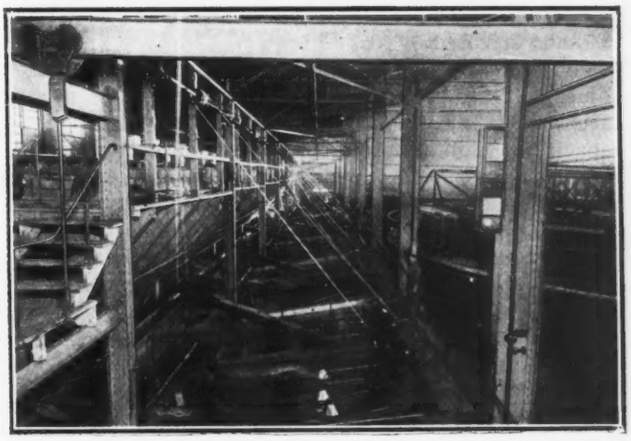
Tons treated	866,524
Assay feed, per cent copper	0.723
Assay tailing, per cent copper	0.468
Pounds refined copper	4,458,100
Pounds copper per ton sand	5.14
Cost per pound copper, excluding smelting and selling, cents	6.40

4. *Leaching Plant*—An article describing this plant appeared in the *Engineering and Mining Journal* of July 14, 1917, written at a time when the plant had been in partial operation for about a year. Since the publication of that article the plant has been doubled in size and the cycle time decreased, so that a daily capacity of 6,000 to 7,000 tons has been reached for months at a time, this tonnage depending more upon the capacity of the plants preceding the leaching process than of the leaching plant itself.

Time of Leaching Now Reduced

As at present installed, the leaching plant has sixteen leaching tanks in two rows of eight each, each tank having a capacity of 1,000 tons of sand. Originally the cycle was four days in length, but changes in strength of leaching solution and plant improvements have cut this down to as low as forty-eight hours, which would permit of a tonnage of 8,000 tons per twenty-four hours.

The material entering this plant consists of a combination of the fine material classified out by the drag belts at the shore plant, of the tailing of the regrinding plant, and the current fine tailing from the stamp mills. As this material enters the plant it is led into sixteen "V" shaped settling tanks each 19½ ft. long, 10½ ft. wide, and 6½ ft. deep. The overflow from these settling tanks contains upward of 95 per cent minus-200-mesh material. The thickened product from these tanks is drawn off by means of plugs to eight quadruplex Dorr classifiers the slime overflow of which joins the original overflow from the "V" tanks after thickening and is treated by flotation. This overflow contains about 93 per cent minus-200-mesh material. The sand discharge from the classifiers is treated by leaching, and although it contains about 15 per cent of minus-200-mesh product, is comparatively free from

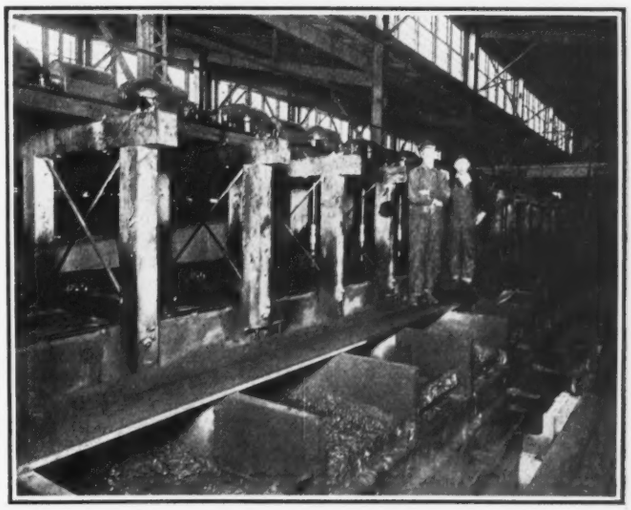


Leaching plant, showing "V" settling tanks, Dorr quadruplex classifier, and leaching tanks with covers in place. Colored lights against column in foreground are signals flashed from plant to plant to show load conditions.

colloids. A characteristic sizing of the feed and tailing of this plant with assays is given below:

		Per Cent Total Material	Assay Feed, Per Cent Copper	Assay Tailing, Per Cent Copper	Per Cent Recovery
On	28 mesh	2.3	0.561	0.283	49.6
On	48 mesh	11.4	0.499	0.140	71.9
On	100 mesh	39.0	0.466	0.099	78.8
On	200 mesh	29.4	0.454	0.092	79.7
Through	200 mesh	17.9	0.966	0.139	85.6
Total		100.0	0.558	0.111	80.1

Originally it was believed that the feed to this plant would not contain over 10 lb. of copper per ton. This may possibly be the average over the entire life of the deposit in question, but occasionally the feed has run as high as 14 lb. per ton. The solutions originally used were very dilute because it was felt that the loss of ammonia would be directly proportional to the strength of solutions used or at least the stronger solutions would require considerable washing in order to free the sand of the dissolved copper and absorbed ammonia. This general fact was found to be true, but, on the other hand, it was possible to increase the strength of solution and thereby decrease the volume required—in other words, decrease the time of the cycle—and by other means to keep the ammonia loss at a low figure. The consumption of ammonia over the



Flotation plant, showing Minerals Separation machines

life of the plant has been approximately ½ lb. per ton of sand treated.

The classification between leaching and flotation slime, obtained by the Dorr classifiers, has been very satisfactory. The quadruplex classifier has given a capacity as high as 1,100 tons of sand actually delivered in twenty-four hours, and it is not sensitive to fluctuations of load. When working at this capacity the percentage of plus-200-mesh material in the overflow increases and the Dorr thickeners give considerable difficulty, but the classification for leaching is at all times satisfactory.

The cost of this leaching operation for 1923 in cents per ton follows:

General expense	5.09
Sand classification and distribution	3.49
Leaching	13.93
Distillation	11.73
Total	34.24
Ammonia (included in above)	8.68

The metallurgical results for 1923 were:

Tons treated	1,664,130
Assay feed, per cent copper	0.513
Assay tailings, per cent copper	0.105
Assay oxide, per cent copper	82.32
Pounds refined copper	13,625,000
Pounds copper per ton sand	8.19
Recovery, per cent	79.5
Cost per pound copper, excluding smelting and selling, cents	4.18

5. *Flotation Plant*—The feed to the flotation plant consists of the overflow of the "V" tanks mentioned above and of the Dorr classifiers. It is very dilute and subject to wide fluctuations in quantity and accordingly in dilution. The Dorr thickeners do not respond readily to fluctuations in feed, and overloading, with its attendant difficulties, is frequent and a source of inefficient operation.

The plant comprises settling units consisting of twelve three-tray Dorr thickeners with diaphragm pumps, four 16-cell 24-in. impeller Minerals Separation flotation machines, a 25-ft. Dorr thickener for concentrates, an 8x8-ft. Oliver filter, and the necessary incidental pumps and compressor.

The thickeners are in two rows of six each, with the feed launder in the center and an adjustable gate in the launder at each machine. The first eight thickeners were of the open type, but four more were required and these are of the connected type. The latter are much heavier in construction and far superior for the fluctuating conditions to which they are subjected. They show an increased capacity over the open type of about one-third, but the best capacity over the twenty-four hours for the twelve thickeners is about 1,800 tons.

The pulp is thickened to a consistency of about three parts of water to one of solids and pumped by means of an 8-in. centrifugal pump to a distributing box feeding the four flotation machines. The flotation oils are added at this same pump. The pulp is fed into the third cell of the machine, and this and the fourth cell are used for agitation only. Cells five to sixteen inclusive make middlings, which is returned to cells one and two for final concentration, the tailings of these joining the original feed at cell three. A final cleaning up of tailings is made by a series of air cells following the Minerals Separation machines.

For flotation a mixture of various coal-tar products is found most effective. The mixture at present used consists of coal tar from a local gas plant, coal tar creosote from the Barrett company, a residual coal tar oil from the Semet-Solvay company, and wood creosote from the Cleveland-Cliffs company, with a little pine oil added as required for frothing. Special flotation reagents have shown no advantage over the oils mentioned. Neither heat nor acid is found necessary, and the consumption of oil is about 1½ lb. per ton of slime treated.

The plant is very compact and efficiently operated, two men only being required for shift work. The extraction is low, about 65 per cent, but native copper does not float so readily as the sulphide, and little that is coarser than 200 mesh is recovered. A characteristic sizing of feed and tailing is as follows:

	Per Cent Total Material	Feed Assay, Per Cent Copper	Tailing Assay, Per Cent Copper	Per Cent Recovery
On 200 mesh	5.97	0.289	0.243	15.90
Through 200 mesh	94.03	0.516	0.157	69.60
Total	100.00	0.502	0.162	67.80

The cost of flotation, in cents per ton, for 1923, with metallurgical data, follows:

General expense	2.78
Slime conveying and distribution	2.80
Flotation	5.47
Royalty	4.49
Total	15.54
Feed to machines, per cent copper	0.453
Tailing of machines, per cent copper	0.164
Concentrates, per cent copper	28.58
Pounds refined copper	2,135,500
Pounds copper per ton slime	5.76
Recovery, per cent	63.89
Cost per pound, excluding smelting and selling, cents	2.70

Summary of Results

The details of operation of the various plants as given above are for the individual units, and the costs and metallurgical data for the leaching and flotation plants include figures pertaining to current stamp-mill product treated in those plants. The portion of the product from these plants to be credited to current mine production is arrived at by difference of assay of feed and tailing. All material is treated finally by leaching or flotation, and as the leaching is a batch operation, each tank containing 1,000 tons, the weight of this product is accurately determined. The weight of material treated by flotation is determined by sampling, the difference between feed and tailing assay, divided into copper recovered, giving the tonnage.

In addition to the cost of the individual units of the reclamation plant as given above, this department bears its proportion of total administrative costs at mine and mill based on number of men employed. For 1923 the complete cost of this operation in cents per ton of sand treated was as follows:

General administration and miscellaneous	4.4
Dredge	6.3
Shore plant	2.5
Regrinding	16.4
Leaching	25.1
Flotation	3.4
	58.1

Tons treated	1,743,100
Assay feed, per cent copper	0.608
Assay tailing, per cent copper	0.124
Copper produced, pound	16,901,200

The total tonnage reclaimed from the beginning of operation up to Jan. 1, 1924, was 7,955,500 tons with a copper recovery of 82,102,924 lb., being 10.32 lb. to the ton, obtained at an operating cost of 6.32c. per lb. As these tailing piles were constituted at the beginning of operation they contained 46,683,000 tons of conglomerate tailing, of which 34,470,000 tons was estimated as available for treatment, with the probabilities that the final figures would exceed this estimate. It is evident that this deposit will constitute a profitable operation for many years and an important source of revenue to the Calumet & Hecla Consolidated Copper Co.

Engineering and the Human Factor

An Outline of the Y. M. C. A.'s Industrial Service Movement

By Fred H. Rindge, Jr.
Secretary, Y. M. C. A. Industrial Service Movement, New York City

Fred H. Rindge, Jr.

RECENTLY the American Engineering Council passed a most significant resolution including this challenging paragraph:

"Engineering education, reflecting closely the attitude of engineers, heretofore has confined its work almost exclusively to scientific and technical training, giving little if any attention to the social and human aspects of engineering enterprises. The American Engineering Council, therefore, speaking for the engineering profession, urges upon engineering colleges an increased attention to the social aspects of engineering activities, and a broadening of their technical training, in every way possible, to develop in engineering students the spirit of, and a capacity for, active leadership, not only in industry but in public affairs."

Note also these words, spoken by E. M. Herr, president of the Westinghouse Electric & Manufacturing Co.:

"The exact and uncompromising methods so necessary in engineering training cannot be applied in dealing with men. Fairness and justice are the cardinal principles to be used always, but in addition, in dealing with people, one must know how to bring the human element into all such relations. When this is properly done, the workman is inspired, stimulated and led into obedience and loyalty to which no severity or rigid rules could drive him."

These things are true. What, then, is being done adequately to train our technical men in understanding the human side of great industrial problems and the right handling of men? To what extent are they developing character, tact, vision, and a sympathetic regard for the human factor in industry?

It will be admitted immediately that many of our engineering schools have been woefully weak in this regard. There are, however, distinct signs of progress. A study of engineering curricula this year, compared with those of even five years ago, reveals a growing appreciation of the need. One discovers many courses in labor problems, industrial management, human relations, human engineering, and similar subjects. Experienced professors give in a personal way to students considerable instruction which is not announced in the catalog, but which sets them thinking along right lines. Many engineering schools announce a series of special lectures dealing with the human factor. On the whole there is cause for optimism, yet in view of the recognized need all this is only a beginning.

The extensive investigations of the Carnegie Foundation for the Advancement of Teaching in co-operation with the Joint Committee on Engineering Education (representing the national engineering societies), and the studies of the Engineering Foundation and other bodies, clearly reveal the necessity for a more comprehensive program. In this connection attention should be called to the Industrial Service Movement of the Young Men's Christian Association. The advisory committee of this movement, composed of prominent business men and engineers, has devised a course on "The Human Side of Engineering," which is a sincere attempt to meet the need from the point of view of the engineering curriculum. A large number of professors, engineers, employers, labor leaders, and others have been consulted in regard to this course and the following suggested outline has been evolved:

I. Introductory—Some Fundamentals—The Human Factor in Industry

Show in an interesting way that the workers comprise the most important element in any industrial enterprise. In the past, machinery and processes have been given much more attention than the human factor. This condition is rapidly changing. Mechanical advance is interrelated with human advance. The age of "drive" in industry makes new demands on man-power. Production depends in the last analysis upon the human factor. Do we realize that the greatest element in industrial success is the ability to deal intelligently with the human factor? Examples of failure are many, due to lack of appreciation of this fact. The relation of theory to practice in the realm of human engineering opens a new field of study. The greatest need of industry and of the world today is for right leadership. How may we prepare ourselves to furnish some of this right leadership?

II. Historical—The Evolution of the Individual Worker

A brief summary of the history of industry with special reference to the influence of changing conditions upon the human factor. Industrial evolution—the changes from serfdom to individual trades, to the use of machinery, to the modern factory system, to the rise of labor organizations, to the larger self-expression in industry. The enlarged use of machinery leading to quantity production. The changing character of industry. The rising self-respect of the worker.

III. Industrial Organization—The Influence of the Modern Factory System on the Worker

Principles and types of factory organization. Plant location partly determined by human considerations. General and department organization and management. Scientific selection of employees. The employment, labor and welfare departments. Other adaptions to changing conditions. Wage systems. The interdependence of men. The strategic position of the foreman. Should foremen, superintendents, and managers be chosen on the ground of their ability to deal sympathetically and successfully with men? Which forces are beneficial and which detrimental?

IV. Human Factors in Production—Problems to Be Solved

(a) General: Capital and labor, immigration, unionism, capitalism, socialism, Bolshevism, syndicalism. Conciliation and arbitration. The cultivation of an intelligent attitude toward these great questions. Human interests, motives and needs.

(b) Working conditions: Hours and wages. The minimum wage. Industrial accidents, occupational disease, insurance, compensation, and pensions. Shop sanitation, lighting, heating, ventilation. Employment of women, child labor, "blind-alley" employments, unemployment. What are determining factors in the efficiency of the individual worker? Do right conditions pay in dollars and cents as well as from the human standpoint?

(c) Living conditions: Housing, proper nourishment, home refinements, home gardens, thrift, and savings. Co-operative stores, credit and banking co-operation. Standards of living and family welfare. What relation has health to efficiency? Can a "home garden" have any effect on a man's work in the shop? Proximity of home to factory. Study of the budgets of typical working families. Neighborhood relationships. Community problems.

(d) Leisure conditions: Amusements, intemperance, political influence, the social evil, education. Why is "big-business" interested in these things? Their relation to working efficiency and labor contentment. Industry's effort to put a premium on temperance and character. Relation of happiness to efficiency.

V. The Ethics of Engineering and Business

Approved standards and methods. The examples of successful men. Relationship of the technical engineer to his employer, to the employed, to the general public. Principles of integrity and character which win in the long run. The new status of the engineer in public affairs.

VI. Employment Management, Vocational Guidance and the Education of Employees

What is the present attitude toward vocational training? Should children be trained for a single job or for a life career? Training apprentices. Methods of educating foreign employees. "The Roberts System" and others. Americanization. Corporation schools, public night schools, correspondence study, special methods of various social agencies. To what extent does improving a man's education increase his working efficiency? The new science of employment or personnel management.

VII. Co-operative Organizations

General: The Church and affiliated societies, Protestant, Catholic, Jewish. The school, social settlement, charities, municipal agencies. Chambers of commerce and manufacturers' associations. Labor organizations. Specific: National Civic Federation, National Safety Council, Russell Sage Foundation, National Society for Promotion of Industrial Education, Young Men's Christian Association, and other organizations dealing specifically with problems above mentioned.

VIII. Legislation and Public Opinion on Industrial Questions

To what extent have welfare requirements been incorporated in federal and state laws? Important specific laws and their influence. Enforcement of laws. What are the benefits and limitations of legislation? Tendencies in industrial and social legislation. To what extent is public opinion a determining factor? The "education" of public opinion. How can the engineer best cooperate with local, state, and federal government in desirable reform?

IX. The Programs of Typical Companies—Industrial Betterment

What has been and can be done effectively along lines of industrial betterment. The relation of all such work to efficiency and happiness. Examples. Typical programs of the betterment activities of selected companies. Are such companies actuated by economic or human motives, or both? Causes of success and failure in "welfare work." The growing movement toward larger initiative and control of such work by the employees themselves. Shop councils, industrial representation.

X. Scientific Management in Its Human Relations

Principles. Importance of motion study, time study, division of labor. The personal factors in the system. The idea of using efficiency systems to help men up rather than to grind them down. How to get the men to understand this. The efficiency with which "efficiency" is applied. Does man exist for industry or industry for man?

XI. Intelligent Handling of Employees

Methods of industrial leaders who have been successful in handling men. To what extent is their success due to this ability? How did they develop it? Reducing labor turnover by right conditions and fair treatment. Dealing with American working men, foreign laborers, colored workers, women, and children. How to understand and deal successfully with the human factor and learn to handle labor. The fair and sympathetic attitude not weak—how can it hurt discipline? The "Industrial Service Movement" idea. The influence of ideals, enthusiasm and loyalty. Have these elements an economic value?

XII. The College Man's Responsibility for Service—The Strategic Place of the Engineer

In the light of the above, what will be your attitude when you graduate? Will your life purpose be wealth regardless of others, or wealth of service for others? Self-interest or social-interest? The engineer often stands midway between capital and labor. He must understand both points of view and help to build a better understanding between the various elements in the industry.

XIII. Industrial and Social Readjustment and Reconstruction

After-the-war conditions. Redistribution of labor. New importance of women in industry. Increased demands of labor. The world labor movement. New world relationships and obligations. Democracy in industry.

The course is planned for a college year on the basis of two or three periods per week for thirty-two weeks. All the topics could not be covered in the time allowed, but a wide variety of choice is possible as can readily be seen.[1]

To be most effective any such course should be supplemented by an occasional Congress or Conference on Human Relations, by industrial and social surveys, the preparation of special essays and reports, human engineering inspection trips, social service libraries and bulletin boards, and particularly by actual friendly contact on the part of the students with industrial workers.

This idea of getting college men and industrial workers together through service really started at the Yale Sheffield Scientific School fourteen years ago and has spread all over the country. I have seen it at work in 250 colleges.

[1]Numerous references have been prepared under each topic, and I shall be glad to send the entire outline to anyone desiring it.

Students have taken up this practical work with a vim and have succeeded admirably. They tell enthusiastically about foreigners they have been instructing in the boarding houses; first aid being promoted in factories, mechanical drawing taught in labor unions, entertainments, shop meetings, and clubs of working boys. It is all real and worth while, and the effect on the students themselves is very evident. Many students join one of the organized industrial research groups in the summer months and study industrial problems under expert leadership while they actually work as common laborers in a factory.

After all, it is by getting to know a group of industrial men intimately where they work or live that makes students appreciate how much backache is involved in a worker's pay envelope. They return to college work with renewed interest. Their point of view is much more fair and sympathetic, and they will certainly be more efficient engineers after graduation, because of these experiences. There is no doubt that such service makes the students more self-reliant, gives them confidence and tact, shows them actual living and working conditions, and trains them in intelligent handling of different types of men. The responsibility of the work and the fact that a group of working men and boys is looking up to them certainly strengthens personal character and ideals. Are not these the very fundamentals most desirable in the engineer today? Although students give their services without compensation, who can doubt that they will be paid in later years many times over, by saving themselves costly mistakes and by knowing how to appreciate the human factor in a way otherwise impossible?

Oil Leases on Indian Lands in 1923 Over 300,000 Acres

Leasings for oil and gas on Indian lands in 1923 by the Department of the Interior exceeded 300,000 acres; the gross oil production was about 54,000,000 bbl., and the revenue to the Indians from existing leases was approximately $37,000,000. In the Osage Reservation, Oklahoma, 67,864 acres was offered for lease, 48,031 acres selling for a bonus of $14,246,600. Several 160-acre leases sold for more than $1,000,000 each, the highest price paid for any one tract being $1,325,000. The Osages received $30,572,111.14 from existing oil and gas leases.

High-grade oil was discovered on the Hogback structure of the Navajo Reservation during the year from a well that has an estimated production of 350 bbl. a day.

To promote better and more uniform administration of the Navajo interests, particularly as to minerals, timber, and development of underground water, Hon. J. H. Hagerman was appointed commissioner to the Navajo Tribe, and a tribal council was completed under regulations approved Jan. 27, 1923, and administrative officers of the government may deal directly with this organization in all matters affecting the tribe as a whole. A co-operative agreement with the Bureau of Mines was approved June 29, 1923, under which thoroughly competent engineers and practical men will be available for efficient supervision of operations for mining coal, oil, gas, and other minerals from leases on restricted Indian lands, except in the Osage Nation and the Five Civilized Tribes.

Upper Mississippi Lead and Zinc Ores—II

By J. E. Spurr

DR. H. S. WASHINGTON[28] estimates the average percentage of metals in the earth's crust as: copper 0.002, zinc 0.000X, and lead, 0.000XX. Bain's averages for zinc in northwestern Illinois, and Winslow's for lead in the limestones of Missouri, correspond with the average estimate of Washington; and the other analyses are closely in the same category. By the current reasoning of the Mississippi Valley geologists, we should then have rich lead and zinc deposits all over the earth; and we should have copper deposits as widespread as the lead and zinc, in the Missouri limestones; and so on. This line of evidence, I repeat, is distinctly unfavorable to the arguments which have been built up on it. As to the traces of lead and zinc in the Upper Mississippi (Wisconsin) limestones having been derived from the pre-Cambrian rocks around Lake Superior, why was not copper thus derived to a greater degree? There is little lead and zinc, but much copper, in these older rocks; copper goes easily into solution, and is precipitated easily by organic matter; and "sedimentary" copper ores are argued as existing in other parts of the world by this same school of geologists.

Another general observation unfavorable to the theory is the firm solid character of the rocks supposed to have been leached. The metals must have been almost miraculously extracted without leaching out the lime, and without disturbing the firm and solid texture. The rocks are of the usual texture of limestones and dolomites everywhere; stopes of unusual height and width stand solidly in the mines, without timbering or filling. Again, the study of disseminated ("porphyry") copper ores has taught us that the downward concentration by surface waters produces a widespread and definite "blanket" of enriched ores at a definite horizon, having a definite relation to the surface.[29] The ores of the region under consideration are not in blanket form, but follow distinct fracture and fissure systems; they have no definite relation to the surface, but they have a relation to certain underground structures and beds, at whatever depth. On the whole, I should say that these general considerations are quite sufficient, in default of other clear evidence, to demonstrate that the ores in question have not been deposited from meteoric waters and that they have not been leached from the inclosing or overlying sediments.

On the other hand, the restricted area of the mining region (concentrating our attention now on the Wisconsin-Illinois-Iowa field), and the occurrence of ore only in certain restricted areas in this region, so clearly pointed out by Bain, while the rest of the same sedimentary series is barren, indicate to me a hidden and not evident origin—that is, an origin whose key is not displayed.

There seems to be no question as to the preferential precipitation of the ores (deposited as sulphides) in the Galena formation; and that perhaps the most favorable horizon for precipitation was above, and to a lesser degree in and below, the "oil-rock" horizon. Since the rock below the "oil rock" is a different formation, of an earlier age (Platteville) than the "oil rock" and the strata above (Galena), this local precipitation cannot indicate original metal content, but a favorable field for the deposition of metals from solutions which coursed through both formations, and indeed probably through the other sedimentary formations represented—as is shown by the ores which occur in these, though in far less amount.

The ore occurs at the intersection of fracture systems with beds favorable for preferential precipitation,[30] as it does in Missouri, or indeed, at Santa Eulalia (Chihuahua) Mexico,[31] or near Monterey, or, indeed, in many other lead-zinc deposits in limestone which I have studied. In Missouri the preferential horizons vary widely in different districts, from the top to the bottom (Carboniferous to Cambrian) of the limestone-dolomite strata.

The fractures in the Wisconsin district are definite and geometrical, so that the orebodies are fairly geometrical also, and show no semblance or close relation to surface features, such as the branching drainage channels of the surface. This has been recognized by all recent writers on the subject. Bain's map[32] shows the surface fractures or "crevices" (containing galena and zinc carbonate) which have been mined in the region. Cox[33] has tabulated these, 1,342 in number. He observes " . . . it is seen that by far the greater number of crevices in the district have a general east and west trend, which is also the general trend of the folds and the "oil-rock" basins, showing rather conclusively that some relation exists between them, the vertical fractures apparently, in part at least, being due to tension and compression developed during folding. These fractures vary from a few inches to one mile or more in length, from a fraction of an inch to three or four feet across, and are limited vertically to a single formation." Inspection of maps of workings in the zinc-lead sulphides at the base of the Galena indicates similar strong fracture control. The predominant belts of ore run E.N.E., and in some cases are continuous for two or three miles; there is also a strong system of ore belts nearly or quite at right angles to the above; and some quartering ones.

Where I observed the ores underground, the steeply dipping, sometimes vertical veins in the orebodies were often clean cut and continuous. They appear, as I said above, to have originated in part by replacement, to a less degree by fissure fillings; and they are bound together by layers of replaced rock. The inclined fractures sometimes run straight, sometimes alternate between steeply dipping segments and intervening flat stretches which run along the stratification planes. This structure ("flats and pitches") results from the repeated deflection of stresses, acting diagonally to the stratification, along the stratification planes. I have described a somewhat similar structure in what I call

[28] "Jour. Franklin Inst.," Dec., 1920, p. 777.

[29] Spurr: "The Ore Magmas," Vol. II, p. 530.

[30] "It seems safe to say," says Cox, (Bull. 21, Ill. Geol. Surv., p. 73) "that about 95 per cent of the ore mined in this district comes from openings or bedding planes more or less enlarged by solution." I surmise, however, that this percentage is too high: I observed considerable replacement in the mines I visited.

[31] Spurr: "The Ore Magmas," Vol. II, p. 877.

[32] Plate VII, Bull. 294, U. S. Geol. Surv.

[33] Bull. 21, Ill. Geol. Surv., Fig. 3, p. 36.

the "step-veins" of the Bachelor mine at Ouray, in Colorado.[34] This structure may explain why in many cases the deeper zinc-lead ores which lie at the base of the Galena formation are often not directly below the lead ores worked at and near the surface, but are offset, though parallel in trend.

Of a vertical vein which seemed to be a fissure filling[35] I made the accompanying sketch (Fig. 4). This is a quite regular vein, though one of many in the stope where it occurs. And along a horizontal fissure I observed this structure: (Fig. 5). Is this not to be interpreted as a first filling of blende, and a later filling of calcite, in an open fissure? And in another case I noted galena between the blende and the calcite, making a succession which has been noted by previous geologists who have described the region. I am informed that next to the walls iron sulphide often comes, then blende, and so on.[36] Now, this succession of, first, sulphides (mainly blende with considerable galena and pyrite) and last pure calcite, shown in the figures above, is the rule in both of the mines that I visited, and was everywhere visible. What is the explanation of this succession? Does it mean that the fillings of these openings along rock fractures (must they not

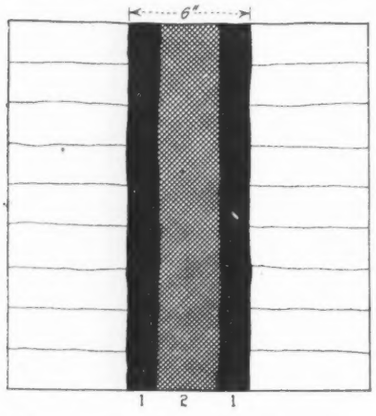


Fig. 4—Vertical sketch section of vein (6 in. wide) in Field mine, at New Diggings, Wis.

Shows first deposition, in a fissure, of sulphides, mainly zinc-blende (1), and a later filling of coarse calcite (2). Vein is in horizontal dolomite walls.

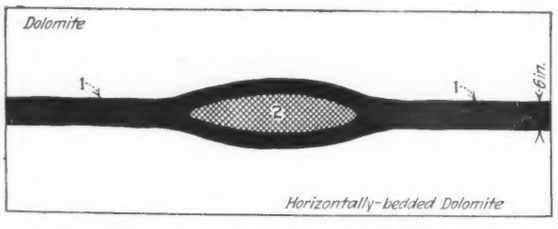


Fig. 5—Vertical sketch section of horizontal vein in Field mine, showing calcite (2) later than sulphides (1), but confined to a lens, or swollen part of the vein

have been open spaces in any case?) were gradually built up by slow deposition from surface waters, and that at a certain definite time the metals were no longer in solution and were no longer deposited; but by a complete change the solutions brought in and deposited pure white calcite only? If so, how can one explain this sudden revolution everywhere in the nature of the solutions? If the solutions were meteoric waters and derived their mineral contents by leaching the rocks, how can we account for such a change? Or, is it possible that these veins were filled by solutions containing both lime and the metals, and that these solutions filled the fissures, and that the sulphides were deposited first and calcite was deposited afterward, from the same solution? The fact that there is no fine banding in these fillings, only the general succession of coarsely crystalline deposits above noted, does not seem to support the idea of a gradual deposition from circulating waters, any more than do the general considerations above suggested. The second supposition fits in more easily to a tangible picture; and it explains, moreover, the typical succession zinc, lead, and calcite, which I observed, as have many other geologists before me. On the theory of gradual deposition from meteoric waters, or indeed from any solutions, the nature of the solutions would have had to change radically twice. On the other hand, if we consider the hypothesis of successive deposition from a single solution filling the fissures, we note that the succession zinc-lead-barren gangue corresponds with the observed succession with falling temperature in or from a heated solution, such as a magmatic solution.[37] These are evidently primary ores, it will be understood, which I am describing; they are below the zone of oxidation; and the sulphides, though frequently with the noticeable order that I have described, are in general the typical mixed zinc-lead-iron sulphides which are found in so many mining districts in the Cordilleran mining region in North America and which here, as usual, require milling pro-

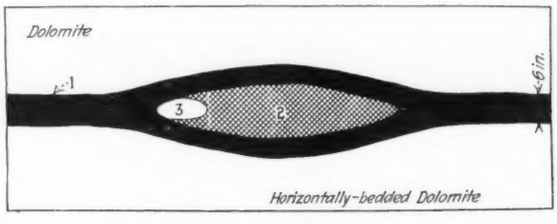


Fig. 6—Vertical section illustrating phase of vein in Field mine. 1, sulphides. 2, calcite. 3, open cavity (water-course)

cesses for disentangling. I find it difficult to explain the regular and general succession of first sulphides and then calcite without accepting the hypothesis that they were deposited from heated solutions, and that the observed succession was produced by cooling. This of course would indicate solutions ultimately proceeding from a greater depth, whatever their origin may have been.

This hypothesis of ascending solutions, we must next honestly observe, does not seem to fit in well with the observed fact that the concentration of the ores on top of the relatively impervious "oil rock" and clay beds at the base of the Galena formation is greater than below these beds—a circumstance, which, of and by itself, would seem to indicate, rather, descending solutions. I

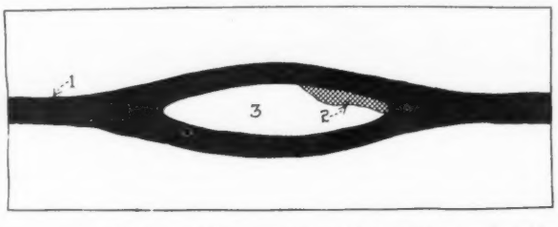


Fig. 7—Vertical section illustrating phase of vein in Field mine. 1, sulphides. 2, calcite. 3, open cavity (water-course)

[34]Spurr: "The Ore Magmas," Vol. II, p. 783.

[35]In the Field mines, at New Diggings, in Wisconsin.

[36]Grant and Burchard: U. S. Geol. Surv., Folio No. 145, 1907, p. 12.

[37]"The Ore Magmas," Vol. I, p. 262.

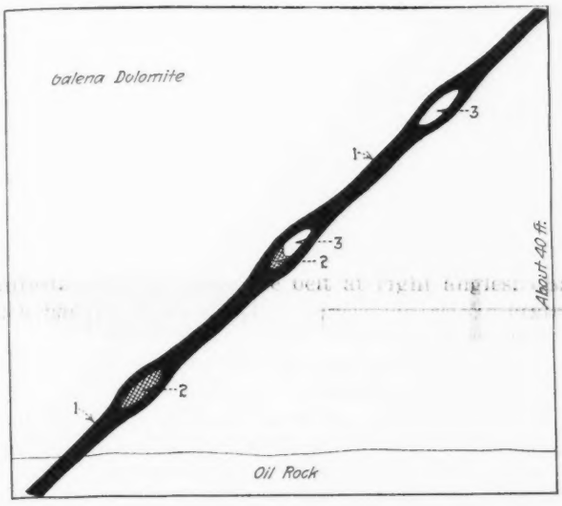


Fig. 8—Vertical cross-section (diagrammatic) illustrating vein seen in stopes of Monmouth mine, Cuba City, Wis. 1, solid sulphides. 2, solid coarse calcite. 3, open cavity (water-course)

will discuss this again later, and in the meantime mention certain other interesting phenomena which I noted in the mines.

In the lower part of the stopes which I visited, the ores, near where they rested on the "oil rock" (also considerably mineralized by replacement) were solid—the calcite fillings and centers of lenses figured above were intact. But ten or twenty feet higher up (the stopes are often forty or fifty feet high) the calcite fillings have "sprung a-leak": surface water pours out of them, out of holes which the waters seem to have dissolved out (Fig. 6); and, still higher up, most or all of the calcite is gone, and where the calcite was is a cavernous water-course. (Fig. 7.) The accompanying sketches (Figs. 6 and 7), from observations made in the Field mine, represent changes like those which I observed in a single strong fissure or vein in the Monmouth mine, near Cuba City, Wis. (Fig. 8.)

The observations above set forth seem to me good evidence that the cavernous openings have originated near the surface through dissolving by oxidizing ground waters. Certainly they seemed in the mines I visited to be absent in the lower part of the stopes. This water pours down into these stopes (as at the Monmouth mine) from the roof: on the other hand, if holes are driven down through the floor, and the thin seam of blue or green clay which underlies the "oil rock" is pierced, a strong flow of water is apt to rise through it, as in the Field mine, mentioned above; and, indeed, this is one of the things that discourages prospecting below the "oil rock." Yet in the cavernous openings, which seem to me to have been formed as I described, the minerals which line the sides, whether calcite or sulphides, are often in very large and free crystals, growing out into the open space; showing, I should think, that, in many cases at least, the dissolving out of the calcite must have been followed by a long period when the cavities were filled by stagnant or slightly moving ground waters, which enabled the observed crystals to form on the walls. The galena, which was mined near the surface, was all, I understand, of this very coarse crystalline character ("cog mineral"), in contrast to the relatively fine crystallization of the galena in the mixed sulphides in depth; and from this it would appear that all this superficial galena had been recrystallized, under the influence of superficial waters, while the associated blende was reduced to the carbonate and the iron to limonite. This phenomenon of secondary (recrystallized) galena persisting in the oxidizing zone of mixed sulphide bodies, while the blende and iron sulphide are completely oxidized, is one observable in many mining districts, as in the Zaragoza[38] and other mines near Monterey, in Mexico. The rearrangement of the ores by superficial oxidizing waters in the Wisconsin lead-zinc district, it is to be especially pointed out, was not more effective than is usual in lead-zinc districts in the Cordilleran region, as in many mines in Mexico, and at Leadville, in Colorado, where the zinc carbonate has been separated from the lead carbonates and sulphides, during the process, to a large degree, and carried into the walls of the lead bodies, or lower down, to form separate workable bodies of zinc carbonate. In this Wisconsin (Upper Mississippi) district the predominantly lead ores occur mainly in the zone of oxidation, above the ground-water level; and the predominantly zinc ores occur mainly below the lead ores; the zinc carbonate ores are found slightly above and slightly below water level, while the zinc (lead, iron) sulphides occur below it.[39] No workable bodies of lead carbonate have been developed, and the galena and zinc carbonates were found considerably mingled in the superficial zone. The flat-lying strata,

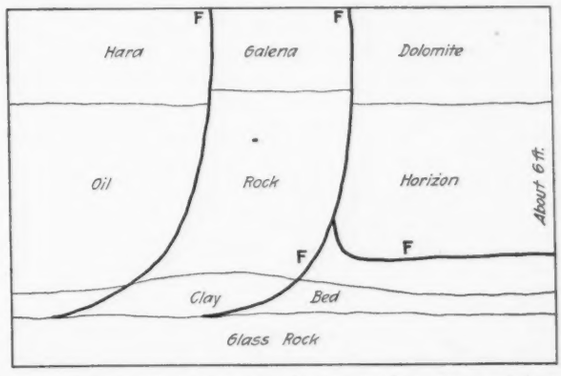


Fig. 9—Diagrammatic sketch of vertical face of barren strata in Monmouth mine, Cuba City, Wis., showing vertical slight fault fissures (F) in Galena dolomite deflected or absorbed by shaly beds below

and relative slight differences of topographic relief in Wisconsin, as compared with Mexico, Colorado, and other Cordilleran regions, of course mean somewhat more sluggish natural ground-water movements; and seem to have resulted in a rather *less effectiveness, if anything, of ground waters in dissolving and precipitating minerals than in the more mountainous regions of the West.* And the primary ores which I observed come within a hundred feet or so of the surface, showing how the regional conditions mentioned above have limited the effect of ground waters to a very superficial zone—more superficial, again, than is usual for more hilly or mountainous regions.

I also observed in the Monmouth mine some structural or dynamic features of interest, in drifts which are away from the orebody, and show in their walls the base of the Galena formation and the top of the Platteville (Trenton). There is shown below the Galena dolomite the "oil-rock" horizon, several feet

[38]Spurr: "The Ore Magmas," Vol. II, p. 534.
[39]H. Foster Bain: Bull. 294, U. S. Geol. Surv., p. 69.

thick; beneath this the soft clay bed, a foot or so thick; and below that the dense limestone ("glass rock") of the top of the Platteville. The bottom of the Galena dolomite shows E.N.E. corrugations, due to fractures,[40] which were steeply dipping or vertical, and the result was rolls in the bottom of the hard dolomite, and even

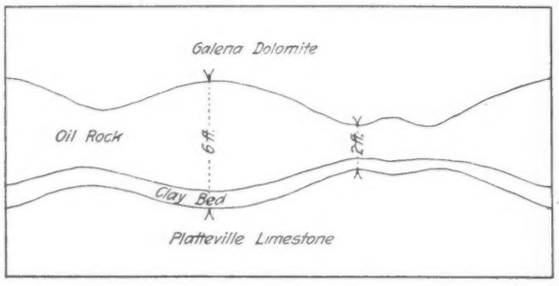


Fig. 10—Diagrammatic sketch of structure exposed at one point in the Monmouth mine, Cuba City, Wis., showing pinching of shale beds at the base of the Galena formation, between the hard formations—the Galena above and the Platteville below

definite slight faults, up to one and a half feet in vertical displacement. This faulting was not observed to pass downward through the shales ("oil-rock," clay bed) into the "glass rock" below, but was in all cases noted taken or deflected by these softer beds (Fig. 9); but in the "oil rock" or underlying clay (the clay seems to me a shale softened to clay by underlying waters) there is not only intense minor faulting, following these fractures, but also sharp folding and brecciation; and this folding and brecciation does not affect the hard rocks above (Galena dolomite) or below (Platteville limestone). The hard limy layers of the shale beds have broken into angular fragments, and separated, and the plastic shales have flowed around them, making a veritable breccia. Evidently the shale horizon has served as a gliding plane between upper and lower hard limestones, as between the "upper and nether millstones." This is shown by another sketch made of another place in the same mine (Fig. 10). This shows that the shale beds were pressed up by the Platteville and down by the Galena millstones.

And while on the subject of the weaker nature of these shales and the less resistance to stress as compared with the rocks above and below, I wish to sketch another feature observed in the Field mine, at New Diggings (Fig. 11). Now, to me at least this occurrence indicates that the vein was filled by solutions

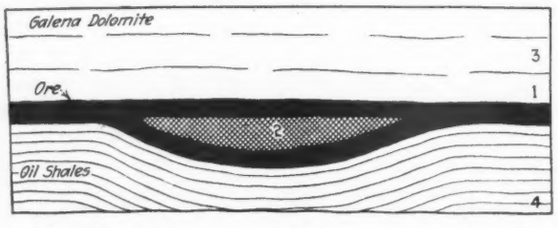


Fig. 11—Diagrammatic vertical cross-section of horizontal vein at very top of "oil rock"; Field mine, New Diggings, Wis. 1, solid sulphides. 2, solid calcite. 3, Galena dolomite. 4, "oil rock" (shaly). The stratification of the shaly "oil rock" is bent down to correspond with the curve of the vein-lens; but the hard dolomite above is undisturbed.

[40]This is the fracture system which has determined the main set of ore "runs."

under great pressure, and that they pressed down the weaker rock. It is difficult to understand, granting this pressure, how the "force of crystallization," so often vaguely referred to, could have accomplished this result, for the calcite was, as I have above shown, crystallized later than the sulphide (blende). I am inclined to the belief that solutions under pressure accomplished this result before crystallization; and contemplation of Fig. 5 again in this connection will, I think, lead to the conclusion that the calcite was an original though later-crystallized part of the ore solution. Certainly, the space filled by this swelling shown in Fig. 11 could not have been a pre-existing cavity, for Figs. 9 and 10 and my description show that the shale has been under great compressing strain.

Finally, I am led (perhaps rashly) to contribute still another hypothesis to the already venerable and imposing list; and if it is still somewhat speculative, it has that element in common with all those that have been previously proposed.

The Galena dolomite, the chief ore-bearing horizon, is covered above by a shale formation, which Cox has considered as relatively impervious: indeed, above it, in the Niagara dolomite, no ore has been found. It (the Galena) is limited below by a thinner and evidently relatively impervious shale bed—the "oil rock"; yet

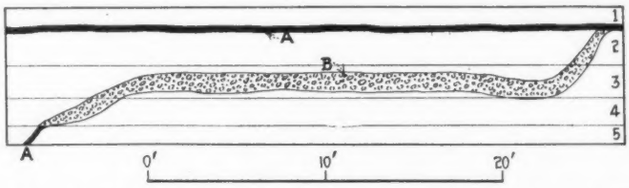


Fig. 12—Vertical section in Gruno mine, Mifflin district, Wis., showing ore continuous from the "glass rock" (Platteville formation) up through the shaly "oil rock" to the Galena dolomite. After Bain, U. S. Geol. Surv., Bull. 294, Fig. 33, p. 100. 1, Galena dolomite. 2, shaly limestone. 3, "oil rock." 4, clay bed. 5, "glass rock" (Platteville limestone). A, solid ore. B, thickly disseminated ore

below this—immediately under it—there are some ores; and some ore (but not much) has been found in favorable formations stratigraphically much lower—near the base of the Prairie du Chien dolomite, for example.[41]

In the favorable Galena formation the ore is limited to definite shoots—not easy to find, so separated by barren areas are they; and these shoots or runs are geometrical, and are controlled by fractures and fissures of dynamic origin. They are the result of stress undergone by the rock at a certain period, after which the metalliferous solutions penetrated along zones of intense fracturing, and deposited the primary ores: zinc sulphides (blende), with iron (marcasite and pyrite) sulphides, a subordinate amount of lead sulphides (galena), and calcite; also, locally, copper sulphides (chalcopyrite).

My sketch (Fig. 9) indicates that as to this dynamic fracturing of the Galena dolomite, the shales at the base acted in many instances to deflect the stress horizontally or to take it up entirely by flowage. The localization of

[41]One commercial mine is reported in the Prairie du Chien, the Lansing mine, in the Iowa corner of this mineral district. The ore (galena) was in a "crevice" or vein, which ran nearly north and south, was vertical, and was followed more than a thousand feet. The ore carried 4 oz. silver to the ton. The production in 1895 had reached 500,000 lb. of galena. The ore horizon is about fifty feet above the Cambrian (Potsdam) sandstone.—H. Foster Bain: Bull. 294, U. S. Geol. Surv., p. 123.

ore principally above the oil rock would then seem to depend upon the greater fissuring due to greater brittleness of the Galena dolomite. The overlying Maquoketa shales also would doubtless not have been fissured by this stress. Thus the whole Galena formation offered preferentially courses or fissures for the flow of the ore solutions. Bain wrote of the Galena formation:[42] "The exceptional development of the crevices is due to the inelastic and homogeneous character of the rock which has allowed the formation of single crevices or bunches of closely parallel crevices extending in a fairly constant direction for some miles."

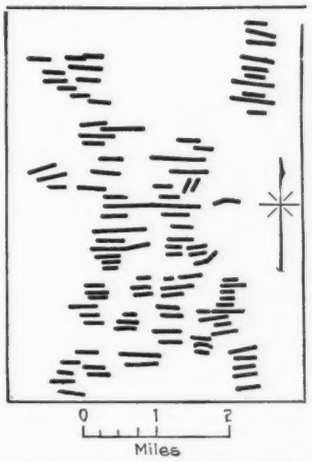


Fig. 13—Mineral veins ("crevices") in the vicinity of Dubuque, Iowa; copied from Pl. VII, Bull. 294, U. S. Geol. Surv. Shows ore belt composed of veins or "crevices." Detail of area 1, Fig. 2

As to the solutions which deposited the ores in these fissures, I postulate, on account of the considerations above given, that they were hot solutions and accordingly they were ascending; but probably they did not usually ascend directly up from below the known and mined ore-runs in the Galena formation, for in these cases, as I have mentioned, the ore seems mainly above the oil rock, rather than below, though, indeed, there has been very little investigation of the rock below. But the observations made above suggest that the fractures in the Galena formation were in some cases deflected by the oil shales, so that their counterpart would in many cases at least not be expected in favorable (rigid) formations directly below. When one considers the "flats and pitches" as "step-veins," and as due to the transformation of an inclined stress, such as would usually produce regular dipping fissures, into slips along stratification planes alternating with vertical cross-fissures; and when one further considers that the lead-bearing "crevices" of the superficial zone are often considerably offset horizontally from the parallel sulphide runs which occur at a depth of 100 or 200 ft., one is led to regard as possible the extension of zones of fissuring below the oil rock, but offset by deflection along it: and to assume that the solutions, rising from the depths, followed diagonal and stepped fissure-zones, persistent, but of very slight displacement, if any. Such a condition is suggested by the accompanying figure (Fig. 12) reproduced from Bain.[43] If this hypothesis is true, there might be considerable ore yet undiscovered at the top of the Platteville formation, though its location would not be too easy a task. Where the galena-bearing "crevice" at the surface is offset from the sulphide body lower down, the ore beneath the oil rock should be expected to be offset in the same direction as the mixed sulphides are from the corresponding superficial vein, in which, on account of the rearrangement by oxidizing waters, principally secondary galena persists.

In some cases, also, ore has been followed vertically down from the Galena through the oil rock to the "glass rock" of the Platteville, as in the much-copied section made by Chamberlin," of the Roberts mine at Linden, Wis., where step-veins ("flats and pitches") in the lower part of the Galena dolomite were followed down into the "glass rock," where they merged into a flat bed of ore.

There is one striking and certainly significant structural feature of this region, which I do not find has been pointed out. On Bain's map,[44] where over a thousand veins or "crevices" on the surface have been plotted, the mineralized areas have the general shape and distribution shown on Fig. 2, in which I have joined closely contiguous fissures in each area. Studying this map, the ore areas are seen to have usually definite extensions, notably in the north-south, and northeast, directions. Any extension of these ore areas in a northwest direction is practically absent. These ore areas or ore belts, as shown, are often five to ten miles long, but typically one-half a mile or less wide, though locally the width reaches a mile or more. But on the original map of Bain these areas are not shown solid, but are comprised of hundreds of veins or "crevices" which have been worked; and these veins are mostly almost strictly parallel one to another, and strike across the direction of elongation of the ore belts and most typically at right angles to them, so that the belt often resembles a stack of poker chips, if I may be permitted to use the simile (Figs. 13, 14 and 15). The veins or "crevices" are not at all weak—they are indeed very strong, straight, and well marked, running from half a mile or less to a mile or more in length, according to the map. The general east-and-west direction of these veins corresponds, as noted above, to the general direction of the longer axes of the gentle undulations in the strata; hence these veins have been held to record dynamic force, and the same general

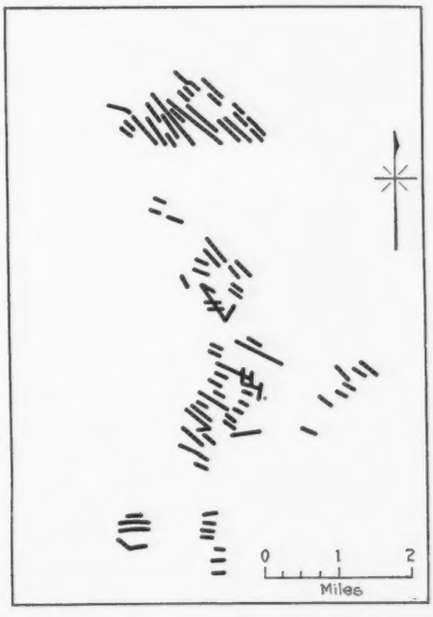


Fig. 14—Mineral veins ("crevices") in the area around Jamestown, Wis. (about five miles east of Dubuque, Iowa)

Copied from Pl. VII, Bull. 294, U. S. Geol. Surv. Shows ore belts composed of veins or "crevices." Detail of area 2, Fig. 2.

[42]Bull. 294, U. S. Geol. Surv., p. 61.
[43]Bull. 294, U. S. Geol. Surv., p. 100.
[44]Geology of Wisconsin, Vol. IV, 1882, pp. 469, 470.
[45]Bull. 294, U. S. Geol. Surv., Plate VII.

force which produced the folds. But besides these numerous parallel veins in each of these areas there is another quite subordinate set of veins of approximately the same average length, which are more or less at right angles to the predominant set. These may be observed in Figs. 13 and 14 and especially in Fig. 15. They are better shown in the map of the Minerals Point-Dodgeville region (Fig. 16). It will be noticed that the subordinate set of veins runs parallel with the ore belt in each case, as the predominant set crosses the belt at right angles. Bain writes:[46] "The crevices

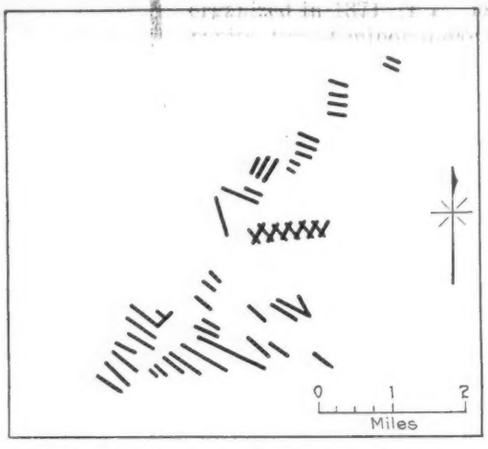


Fig. 15—Mineral veins ("crevices") in the areas around Potosi, Wis. (ten or fifteen miles north of Dubuque, Iowa). Shows ore belts composed of veins or "crevices." Detail of area 3, Fig. 2

Copied from Pl. VII, Bull. 294, U. S. Geol. Surv.

bear definite relationship to each other. The major ones run very nearly east and west. They are crossed by a second set at almost exactly a right angle, which is significant, as is also the fact that the major crevices are nearly parallel to the low, broad folds which cross the region."

It strikes me that these ore belts are certainly a more important structural feature than the constituent veins which make them up, or the slight and so far as known not very persistent undulations of the strata. And to explain them I throw out the hypothesis that these individual ore belts overlie upward intrusions or protrusions of igneous rock which never reached the surface; that after the upward movement or protrusion of the igneous bodies whose shape is roughly indicated by the belts, subsidence and contraction took place, and two sets of fissures were developed, one at right angles to the trend of the subterranean intrusion, the other set parallel to it; and that these fissures became the channels for magmatic solutions which deposited the ores. And if this hypothesis be considered quite too far-fetched, I await another which explains the observed phenomena. Regarding the origin of fissure veins, I have written:[47] "And we note the law that in an intrusive mass of elongated shape, two sets of contemporaneous veins may develop at right angles to each other, and parallel with the longest horizontal axis of intrusion, and the shortest, respectively. Therefore, where we find this fact of two sets of contemporaneous veins at right angles to each other, as we do in the Eden mine, in Nicaragua (p. 665), we may suspect that they may indicate the shape of intrusion of the volcanic rock in which they occur, although we may have no other evidence of this." And I have recorded also the conclusion that the Mississippi Valley region was underlain by a basic magma province: "The combined Mississippi-Appalachian province, therefore, which lies between the Rocky Mountains and the Atlantic Ocean, has exhibited igneous intrusion only twice since before the Mesozoic—east of the Appalachians, at the close of the Triassic, and west of the Appalachians, after the close of the Cretaceous. At most of these periods the igneous rocks were entirely very basic and were extremely basic in the latter manifestation. A region like the Mississippi Valley, which has remained fairly static and low-lying since the beginning of the Cambrian, is on this account alone indicated as underlain by basic magma; for gravity measurements of the crust indicate that such areas are under-

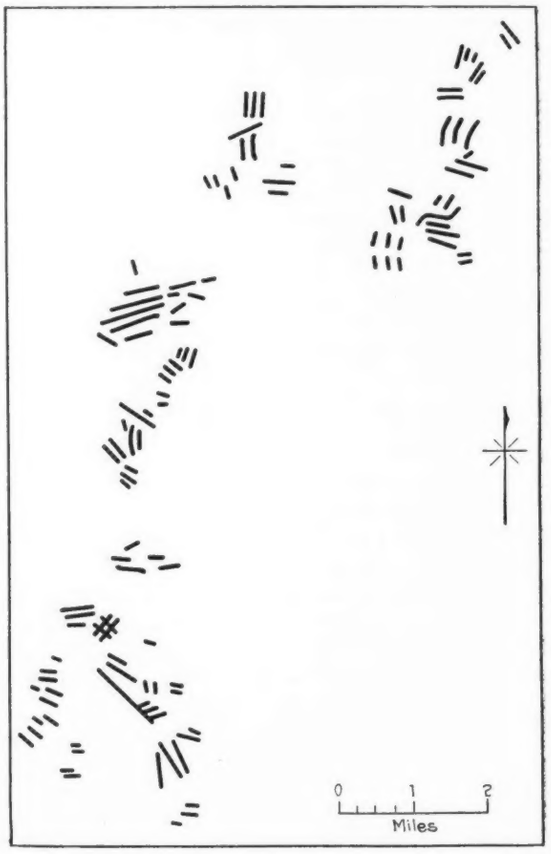


Fig. 16—Mineral veins ("crevices") in the region between Mineral Point and Dodgeville, Wis. Shows two sets of veins or "crevices" at right angles to one another; also the major ore belt composed of all these veins. Detail of area 4, Fig. 2

Copied from Pl. VII, Bull. 294, U. S. Geol. Surv.

lain by heavier rock than are the elevated land areas."[48] And writing of the post-Cretaceous basic (peridotite) dikes in southern Illinois, which are in the region of fluorspar veins, with some lead and zinc, I observed:[49]

"That the intrusive force in the belt of basic dikes under consideration was nicely balanced with gravity and temperature, with no excess motive power, is suggested by the case of the dike reported to me in one of the fluorspar mines, which stopped before it reached the surface, but was uncovered by mining. This also explains why igneous intrusions are rare in the Mississippi province."

[46]Bull. 294, U. S. Geol. Surv., p. 60.
[47]"The Ore Magmas," Vol. II, p. 725.
[48]"The Ore Magmas," Vol. I, p. 404.
[49]"The Ore Magmas," Vol. I, p. 401.

DISCUSSION

The Real Cost of Mining

THE EDITOR:

Sir—Your recent editorial on the cost of copper is both timely and pertinent: timely because of the present confusion of ideas induced by the whole vocabulary of new terms evolved to meet the requirements or exigencies of the federal income and excess profits taxes; pertinent, because there is no little danger that in this confusion the copper mining investor, in addition to his normal hazards, may be innocently misled by the anticipation of dividends which he can never receive.

Mr. J. R. Finlay called attention some years ago to the fact that the real cost of any mining operation is the difference between total receipts from all sources and dividends paid to the stockholders. This he has called the "dividend cost" and points out that it is the only cost in which the investor is interested. These costs are readily ascertained for any of the well-known copper mines by a study of their performances. The only danger in interpreting such histories lies in the importance to be attached to the question of management. Herein copper mining differs in no respect from any other industry. It suffers from the failures and benefits from the successes of those directing it.

There are many factors which point to the conclusion that copper mining, like that of coal and iron, is fast becoming a matter of competitive skill in management and losing its former similarity to precious-metal mining, with its bonanza rewards. If you will pardon a personal reference, I should like to remind you that I contributed a rather lengthy discussion to your pages last year under the title of "Comparative Earning Power of Capital Invested in the Copper Industry." One point which I wish to emphasize is that due weight should be given to the fact that the competition is no less keen in the wise handling of increasingly large amounts of capital required by the industry than in the technical direction of its operations.

New York. ARTHUR NOTMAN.

Antidotes to Cyancide Poisoning

THE EDITOR:

Sir—The regrettable death of Sergio Bagnara, to which you call attention on page 927 of your issue of Dec. 1, 1923, and the remarks made in the article prove only too clearly that even now information is not sufficiently widespread among chemists as to what should be done to prevent fatal poisoning. Unfortunately, familiarity does induce chemists to rely far too much on their personal skill in the use of a pipette, without one of the many simple safety fittings that should always be used when handling poisons of this class, the simplest and safest being an india rubber ball and clip attached to the pipette, or else the use of the pipette in a tall glass jar, neither method involving the mouth at all. But whether in the laboratory or in works it was long ago recognized to be highly desirable that means should exist for the immediate administration of antidote in the rare cases of accident with the liquors.

Prior to Dr. Martin's valuable research on the matter we possessed no accurate information as to what should be done to treat a case of poisoning by cyanide. The poison is so rapid and death is caused by such a small quantity that the accumulation of any useful evidence merely by chance has been impossible. In 1899, when as government metallurgist to the State of Victoria it was necessary for me to deal with the matter officially, owing to the then recent purchase by the department of the patent rights for the cyanide process, the first step was to have this research made, and to discover whether hydrogen peroxide, cobalt salts, or ferrous salts with caustic soda were reliable or not.

It cannot be too widely known that both hydrogen peroxide and cobalt solutions were proved to be useless, and good reason can now be seen why they are so. But, although the results of the research showed that ferric oxide freshly precipitated from ferrous sulphate by aid of caustic soda is useful, this was shown to require the simultaneous presence of much alkaline matter to neutralize the natural acidity of the stomach, and so to render the antidote effectual; this alkali is provided in the form of magnesia. The prescription was first communicated to a local medical society, before the Victorian Mines Department had any opportunity to review the matter from the works point of view, and before the very serious problem of the provision of the means to prepare instantly the ferric oxide away from a chemical laboratory had been dealt with. A satisfactory container painted red, from which the administration of the antidote could be made within twenty seconds, was eventually constructed in the departmental laboratories, and a local firm supplied the works with these containers at a cost of about $2 complete. I inspected one such set over five years after it had been made, and it was still in good order, although a few years later its solution of ferrous sulphate began to deteriorate.

There is need in constructing emergency sets always to take particular care with this solution of ferrous sulphate, and to have it made from the freshly crystallized salt collected from pure solutions, and not only to boil the solution strongly before sealing it in its store tube, but to perform this last operation while the solution is still boiling, and so avoid the presence of dissolved oxygen gas in the water. It is such neutral ferrous sulphate solution that will keep fresh and clear for some years, ready for use. Administration of the antidote must be so prompt that there is not time to make up solutions from solid salts. Complete directions for the preparation of the emergency sets were given in a paper "First-Aid Treatment of Acute Cyanide Poisoning," published in Vol. XIII (1903-1904) of the *Transactions* of the Institution of Mining and Metallurgy. HENRY C. JENKINS.

London.

Earthquake Shocks at the Toi Mine

THE EDITOR:

Sir—In your issue of Dec. 15, 1923, which arrived today, I read with interest Mr. H. Nishihara's account of "The Earthquake and Fire in Tokyo." I note, however, that, "inter alia," he states that "the Toi gold mine, which is situated on the northwestern shore of the Idzu peninsula, is said to have been practically unaware of the great earthquake, and all underground as well as surface workings went on as usual." Mr. Nishihara has evidently been misinformed, for although the effects of the quake were not anything like as severe here as in Tokyo and Yokohama, I can assure Mr. Nishihara that we were all very well aware of the earthquake. A great number of the inhabitants of Toi hurriedly left their dwellings near the sea, and, with their families and belongings, took refuge in the mountains, as they feared a tidal wave. It is true that very little material damage was done at the mine, with the exception of the foundations of the steam-generating plant, which were so damaged as to render running unsafe.

It was the fact that the shock was so severe here, and yet with so little damage, that led me to record the fact in my letter which appeared in your issue of Nov. 17.

J. NORMAN WYNNE.

Toi-Mura, Idzu, Japan.

Producers vs. Consumers

THE EDITOR:

Sir—Your editorials of Dec. 1 and 15, entitled "Gold Miners' Marketing Problem" and "Facts vs. Illusions in the Copper Industry," are certainly refreshingly frank, as discussions of the tariff question, when compared with the usual buncombe offered on the subject by the average periodical. In spite of the fact that this question has been dug over by students, from grass-roots to bedrock, for the last century, until there remains not a single color of doubt as to the nature of its phenomena, the mass of voters are apparently as ignorant of the results of this exploration as if Henry George's "Protection and Free Trade" had never been written.

Under the machine system of production, which was born about the same time as the Constitution, the production of any commodity tends to fall into the hands of a few factory owners, while its consumption, as formerly, is performed by a multitude of disunited and obscure people. Thus an advance in the price of a commodity, which may mean fortunes for its few producers, is seldom sufficiently heavy to make it worth the while of any individual consumer to expend much of his time or money to combat it.

Here in Mexico the tariff satirist can find a wealth of raw material for his diatribes. The system of protection, closely imitated from French and American models, was first introduced by the Minister of Finance, Limantour, about thirty years ago. At the fall of Diaz in 1911, the "infant industries" he had thus fostered had driven out imported articles in many lines and the local consumers were thereby able to secure an inferior "national manufacture" at a large advance in price over its former European equivalent. During the revolution, the producers have worked their will, even more fully than formerly, with the political leaders, and consumers of every protected commodity have suffered accordingly. The latter comprise 90 per cent of the population, while the beneficiaries are the factory owners and such of their men as have been able to form labor unions of sufficient strength to force their masters to "divvy up" on the loot. The misery caused by protection is especially noticeable among the rural population, where the resulting high price of cotton cloth, their only clothing, has forced large numbers to go in rags, or nearly naked.

In this country of peons, the favorite defense of protection in the United States, that "one must guard against the pauper labor of foreign countries," would be too ludicrous for even a venal press to sponsor, so we hear instead: "Protection is essential to prevent unemployment," or "Without protection all our national industries would perish." The revolutionary "reformers" have done nothing as yet to rescue consumers from the tariff bandits, and those producers whose output must be sold at the price of foreign markets have felt the dire effects of this inaction. These latter include the silver, copper, zinc, gold, and lead miners, who are not only hampered by the increased living costs of their workmen, but are directly mulcted by the increase of the cost of such supplies as explosives, lumber, and metal goods. If free trade were once established, Mexican metal miners could flourish like the green bay tree, if also they were insured against revolution. At present writing this latter "if" may appear bigger than the former, but they are really interdependent, as future events will perhaps soon demonstrate.

ROBERT B. BRINSMADE.

Ixmiquilpan, Hgo., Mexico.

The Coal-oil Can Library

THE EDITOR:

Sir—This is Christmas, and we have a day off, and I am writing letters, but I am in a difficulty. So, naturally—like most human beings—I look around for some one to help me out. My question has to do with the choosing of a periodical. If it was the choosing of a chemical journal alone, it would be an easy matter; but I am interested in the progress being made in physical knowledge, too; and it is not practicable for me to take more than one publication of this kind. This is the difficulty; and it comes from having arbitrary lines drawn in science, although they may be necessary—we need stone masons as well as bricklayers. I thought there must be some scientific journal that gives the more important advances at least that are being made in these two branches of science.

One might think it strange that I should want such a periodical and go to all this trouble of worrying people in order to get it—but it isn't. I just simply have a natural desire for knowledge of fundamental things, and it grows and grows. It is not possible for me to have many books; in fact, I am limited to the number that will go in a coal-oil can. This is because they are sometimes left in places where they have to be protected from damp. Space being limited, I cannot help noting that if by some chance a book of light specific gravity gets into this can it is soon crowded out by one of a more substantial sort. I am neither architect nor worker on this towering structure of knowledge that scientific men are rearing; I am of the groundmass on which the foundations are laid. This has certain advantages. It enables one to get a good close-up of my immediate surroundings. I am often filled with misgivings as to the stability of the structure. Knowledge

is the sole product of this or any other civilization, and I know if this structure falls—it's good night! I have never been in an earthquake; nor have I ever been an eye-witness to a tidal wave; but the avalanche is common in this region, and one may easily observe the phenomenon of the inert mass energized into action without direction or guidance—or is it misdirection and misguidance? I wonder if there is something "real" in this age-old struggle that ancient peoples have observed—without understanding—even, as you and I—or is it just a negative? And there are times (right now—today) when, after putting in my shift, I am too tired to read, or even think, I know that I am this inert mass—this clod—this piece of human granite—the same stuff that not dreams, but avalanches, are made of.

The horizon has always beckoned me—the literal one. But there is another—an invisible one—that is not far away at all. It is quite close. One may gain an idea as to what it is by glancing at the titles of these books. It will be noted that most of them are on chemistry; then there are others, such as the "Electron," a collection of several articles on "Photo-synthesis," "Catalysis," "Electrolysis" (what funny names!), "Colloids," "Thermodynamics." (Another queer name!) I wonder what is in it? Let us see—what is this? "The energy of the world is constant; the entropy of the world tends toward maximum zero." Entropy? What a bizarre word! This is the invisible horizon that beckons insistently to me. There is a reason for this—and I know what it is. All of my thinking is underlain by one basic premise: I visualize a universe of eight entities. I do not know why I do this; but I know that it results from no process of theoretical reasoning. I will not name these eight entities—these eight notes in the octave of the Universe—they are too obvious; nor will I try to arrange them in their proper sequence—nor to reveal their hidden meaning. I will name one of them, however: It is Mind—and it comes first.

I conceive of Mind as hovering over us, benign and beneficent, like a dove seeking for a place to settle; it no sooner does that than it is seized by this churl—this ill-begotten offspring of an unholy union between matter and energy, and trampled in the mire, from whence it arises, bedraggled but immutable. Is Mind to be forever frustrated thus? I will not believe it. If the race is to attain to heights from whence it may see on beyond the horizon, it means more knowledge—and still more knowledge (and what is knowledge but Mind?); but knowledge can only be gained by the expenditure of energy—and the clock is running down. Listen! Here is a "Treatise on Chemistry." It represents the product of the unselfish lifework of many, many men; to the race, if its progress is to continue onward and upward, this vast store of accumulated chemical knowledge is priceless, because, the age lying immediately ahead is the Age of Chemistry. Yet—today: What do I see all around me? I see the mirror-image of a Materialism that would bring this all to naught: trying to seize this invisible, intangible energy that we disguise by the name of wealth.

On the head of a stream putting into the Lower Yukon there is a cache: of a pick and a shovel and a gold pan and a blackened, dog-eared book. It is on the "Periodic Law of the Elements," which has been the "mariner's compass (the guiding star), to the scientist." In making up my pack I had always put this in first in case anything had to be left—a strange companion one might think; but this time I was having to leave it, and before caching it away I cut out one leaf—its heart you might say—and took it with me. (I have it now.) On one side the elements are arranged in their familiar eight groups, in two dimensions; but on the other side they are represented helically—and they fall literally into figures of eight.

I could not have written this letter to any one but you, Dear Editor, because—you, too, knew the Yukon when a glory and glamour rested upon it—not of gold, but of youth. Many people—perhaps most people—would consider the request contained in it a matter of but small moment; but it is not to one whose lot falls among men who regard as worthless the things he holds of highest price—men to whom energy is a word and nothing more.

Anyox, B.C. JOHN PETERS.

Tin in the Black Hills

THE EDITOR:

Sir—We notice with interest an article in your issue of Jan. 12 by H. E. West, entitled "Early Tin Mining in California." On page 57 of this article he speaks of Harney Peak in the Black Hills of North Dakota, whereas Harney Peak and the Black Hills are in South Dakota. He further states that an extensive low-grade deposit was being exploited. And, "Captain Josiah Thomas, manager of Dolcoath mine, in Cornwall, was commissioned to report. His report was unfavorable and the mine closed."

As a matter of fact the commission was given to Captain James Thomas and his report was very favorable, as per copy of original report which is herewith inclosed, from which you will note he makes the following statement:

> "In conclusion we would state that with practical working on an extensive scale, these combined properties are capable of producing tin of refined quality, to an enormous extent, with large profits resulting and we have no hesitation in recommending these mines to the attention of capitalists.
>
> "THOMAS MICHELL, late manager of St. Ives Consols, tin mine, Cornwall.
>
> "JAMES THOMAS, late agent of Pedn-an-drea tin mine, Cornwall."

The most thoroughly developed of these mines are owned and operated by this company (the National Tin Corporation).

We also have on file a copy of a report made by Dr. A. R. Ledoux, made Dec. 3, 1909, for the owners of these properties at that time, and which confirms the report made at that time by Captain Thomas and Captain Michell, and he also recommended certain development work to be done. Since that time we have developed the properties further, installed equipment, and are preparing to get into production on some of these ores which we hope soon to announce to the public.

As a matter of fact, actual shipments of both tin concentrates and block tin were made from these properties as late as 1919. And only as late as April, 1922, the Mining and Metallurgical Society of America quotes Dr. Ledoux as follows: "Speaking of tin, he felt that the future for this metal in the United States is by no means hopeless, and expressed the belief that at some time it would be produced in considerable quantity in the northern Black Hills of South Dakota."

New York. SIMON LEDERER.

THE MINING NEWS

The Mining News of ENGINEERING AND MINING JOURNAL-PRESS is obtained exclusively from its own staff and correspondents, both in the United States and in foreign fields. If, under exceptional conditions, material emanating from other sources is published, due acknowledgment and credit will be accorded.

Summary of the Week

PROBLEMS of the non-ferrous metal producers are summarized by the Senate Commission of Gold and Silver Inquiry. Spread between production cost and selling price is inadequate. Specific remedial suggestions are expected later.

The "rebellion" in Mexico has not materially interfered with mine operation according to advices from Mexico City.

Purchase of a valuable forty-acre tract on the Kearsarge lode adjoining Ahmeek ground has been announced by the Calumet & Hecla Consolidated.

The possibility of erecting a lead smelter near Prince Rupert, B. C., to treat Keno Hill ores is suggested by activities of Treadwell engineer.

Government geologist finds good opportunity for further prospecting in northwest Quebec gold belt.

Curtailment of mill operations to a single-shift basis pending the rebuilding of depleted ore reserves is the new policy of the California Rand Silver company of Randsburg, Calif.

Acquisition of the Davis-Daly property by Anaconda will probably force the East Butte company to shut down its smelter at Butte.

Electric locomotives in addition to electric shovels have been purchased for the Wabigon iron mine at Buhl, Minn.

Two fluorspar mines in southern Illinois are flooded and production has ceased temporarily. Hillside company continues to operate.

The Leadville Mines Co. has shut down its mill near Gerlack, Nev., to deepen the mine shaft. This work is in progress.

C. & H. Consolidated Buys Mineral in "40" Adjoining Ahmeek

Valuable Tract on Kearsarge Lode Brings $200,000—Will Be Mined Below 3,500 Level, Through Ahmeek Shaft

The mineral rights of an additional forty acres of land, underlaid by the Kearsarge lode have just been purchased by Calumet & Hecla Consolidated for its Ahmeek property. The transaction is one of the most important in the Michigan copper district in recent years, for the territory acquired adds many years of life to Ahmeek's No. 2 shaft, in the richest portion of the Kearsarge formation. The acreage brought probably the highest price for mineral reservations ever recorded in the district, the $200 in revenue stamps on the deeds filed in Keweenaw County indicating a price of $200,000.

The forty acres acquired are northwest of No. 2 Ahmeek shaft and lie between Ahmeek and the Douglass Copper Co.'s property, giving Ahmeek a wedge into the latter tract. The village of Ahmeek is on this acreage. Calumet & Hecla Consolidated purchased the mineral rights in the "40" from Thomas F. Cole, of New York, who owned an undivided three-fourths interest, and the Northey estate, of Houghton, which owned an undivided one-fourth. The Douglass Copper Co.'s property is north and west of Ahmeek's new tract, Allouez is southwest and Ahmeek proper south and east.

The Kearsarge lode enters the "40" at a depth of 3,500 ft. No. 2 shaft, Ahmeek, is now down more than 3,200 ft. on the dip of the vein. No. 2 can now be carried down on the lode to a depth of 4,000 ft., at which point the formation enters the Douglass Copper property. No. 2 shaft has an immense tonnage remaining in Ahmeek proper, but the new "40" provides an area that will greatly increase its life. No new equipment will be needed to mine the ground acquired, No. 2 shaft being equipped with a hoist capable of hoisting two ten-ton skips in counterbalance from a depth of one mile.

Safety Suggestions Worth $25

THE Tri-State branch of the American Mining Congress has offered a prize of $25 for the five best practical suggestions for making mining in the field more safe. The contest is open to all mill and mine foremen. H. H. Wallower, D. C. McKallar, and John W. Newton comprise the committee having the contest in charge. The names of the winners will be announced soon.

Ore Shipments from Several Colorado Districts Increase

Telluride Produced 151 Cars of Concentrate in January—Durango Smelter Handled Largest Tonnage in History

Ore and concentrate shipments from the San Juan district in Colorado show an increase over like periods last year. Shipments from Silverton for January were 153 cars, principally concentrate, compared with less than half that number in January, 1923. Surpassing shipments during January of 1923 by six cars, the Smuggler Union, Tomboy, and Black Bear sent out 151 cars of concentrates from Telluride during January of this year.

The January output of the Cripple Creek district shows a small increase over that of December, 1923, and a substantial gain over the same month in 1923. The power company furnishing energy for the mines of the district reports a 25 per cent increase in gross business as compared with a like period last year.

The Durango plant of the American Smelting & Refining Co. in January handled the largest tonnage in its history. The Leadville smelter, on account of the closing down of the Rawley mine, showed a decline as compared with the later months of 1923, but was practically the same as in January, 1923.

California Rand Silver Cuts Mill Operations to One Shift

Premier "Straight Silver" Producer Forced to Policy of Intensive Development—Pittman Act Partly Responsible

The California Rand Silver company, operating the well-known bonanza silver mine at Randsburg, Calif., has announced that its mill operations for the present will be curtailed to one shift instead of running three shifts, and that the regular dividend disbursement of 2c. per share, or $25,600 monthly, will be discontinued until ore reserves are increased by intensive development. For four years the company has paid 2c. per month and in addition has paid four extra dividends of 10c., making a total of $3,018,400 in dividends. The mine is unique in that high-grade ore at grass-roots enabled it to pay dividends virtually from the start. The mine has been the biggest producer of silver in the country from "straight silver" ores.

An announcement from the directors to the shareholders explains that during the life of the Pittman Act, while silver was bringing a dollar an ounce, much of the energy of the management was directed to the extraction of ore in order to market the product at that advantageous price. When the Pittman Act expired, in June of last year, all ore deposits easy of access had been pretty thoroughly exhausted and the management faced the problem of extracting from 350 to 400 tons of ore per day to run the mill to its capacity. It became increasingly more difficult to produce the required volume of ore, so much so that during January the mill was idle 20 per cent of the time, due to ore shortage, thus also heavily increasing milling cost. Mining costs are likewise increased under present conditions. The report says:

"Further, the necessity of producing a maximum quantity of ore daily is seriously interfering with the proper development of the mine, and established orebodies are rapidly being depleted, without corresponding location of new deposits, a situation which, if permitted to continue, must inevitably result disastrously to future operations.

"Under these conditions, the board deemed it sound business judgment to place in effect this policy, the same to be pursued so long as it shall be necessary:

"1. To reduce milling operations to one shift per day of eight hours.

"2. To build up an ore surplus that will insure the operation of the mill at full capacity when three full shifts shall be resumed, which will be at the very earliest day practical.

"3. To increase development work by at least 50 per cent over the present footage.

"With this program determined upon, pursuit of which means a temporary reduction of revenue to about $48,000 per month gross, it was deemed unwise and unsafe, with due regard to the future interests of the property, to continue, during the time of curtailment of mill operations, to pay dividends from the surplus funds on hand, funds which may very largely be required for proper development of the mine.

"The large bodies of ore near the shafts or center of operations have been rather thoroughly explored and a fair estimate can be made of the available ore supply in this territory. The opening up of future orebodies will require a higher proportion of development work than has been necessary in the past as the unexplored territory lies farther from the center of operations.

"The development work during the past six months has proved satisfactory and three promising ore zones have been opened up—namely: the so-called Gold Zone on the eleventh level, the ore body on the seventh level in the No. 6 shaft, and the body in the 994 drift on the ninth level. At the present time there are about 8,000 tons of broken ore in the mine. Of this amount 3,500 tons are immediately available as the balance must remain until completion of the stopes."

During January 8,106 tons of ore was milled, averaging $18.104 per ton. Concentrate shipments totaled 456 tons, which netted approximately $106,776.

At the mill new equipment for the drying of concentrates has been installed and is now in successful operation, materially reducing the expense of caring for concentrates, as well as cutting down the freight charges.

Chino Orders First 8-yd. Electric Shovel

THE Chino Copper Co., at Santa Rita, N. M., has just purchased one standard model 350 Marion electric shovel. The machine is to have an 80-ft. boom and an 8-yd. dipper, with four wheel propelling trucks and double equalizing device. This is the first electric driven shovel to be put in operation at the mines in Santa Rita; it is approximately twice the size and capacity of the steam shovels now operating at the property. The machine was ordered to be delivered from stock and it is expected to arrive in Santa Rita soon.

Leadville Mines Co. Will Suspend Milling to Deepen Shaft

The Leadville Mines Co., operating 40 miles north of Gerlach, Nev., has recently opened up a new orebody west of a prominent crushed zone which had heretofore been considered as the west boundary of the oreshoot. The ore has been drifted on for 40 ft., and has been proved to extend at least 30 ft. above the level. The ore is from 18 in. to 2 ft. in width and carries 6 per cent lead and 30 oz. silver per ton. The shaft is to be sunk from the 500 to the 600 level, and as this work will interfere with regular mine production the mill is to be shut down for six weeks, or until this shaft work is completed. The mill uses flotation and has been treating from forty to fifty tons of ore per day.

Mexican "Rebellion" Has Not Seriously Hurt Mine Operations

Government Asks Advance Payment on Mining Taxes—Gold and Silver Production for 1923 High

By W. L. Vail

Mexico City, Feb. 1—Though mining operations in Mexico have been affected unfavorably in certain sections, due principally to the disorganization of transportation, on account of the "rebellion," in the main there is little to complain about. Where rebel forces have invaded mining camps they have not interfered with the work, nor levied assessments on the operating companies, restricting themselves to seizing government funds. At this writing, the government apparently is gaining the upper hand in the contest, and hopes are entertained that within a reasonable time the country will return to temporary normalcy.

Many of the companies have responded to the government's appeal for an advance payment on mining taxes, the same to be deducted proportionately from subsequent taxation during the year. In a few instances, local management have declined, alleging the necessity of consulting their foreign stockholders. It is believed that failure to make the requested advances will be followed by a heavy fine.

According to latest reports issued by the Department of Commerce and Industry, 1923 was a banner year in metals production for Mexico.

The gold output from January to the end of November, 1923, was 22,325 kg., to which is added an approximation for the month of December, giving the figures 24,354 for the year. The total for 1922 was 23,276. kg.

Silver production for the same period was 2,552,550, plus the approximation for December, making a total of 2,782,600 kg. for the entire year, as against 2,521,832 in 1922, or an increase of 260,768 kg.

Lead by the same calculation, produced in 1923 amounted to 151,056,347 kg. and copper, 51,851,146 kg.

In making up the annual report the department has been unable to give exact figures for the states of Oaxaca, Jalisco, and Guerrero during the month of December, as these states have been controlled by forces in hands of those rebelling against the government. It is believed that the figures from these states will, however, run over the department's approximations rather than under, as mining activity in these zones has not decreased.

Trinity Dredge to Be Reconstructed

The gold dredge operated by the Trinity Dredging Co. on the Trinity River, five miles above Lewiston, Calif., will be rebuilt during the year. Contracts have been let for constructing and operating a sawmill to supply the timber for a new hull and superstructure. Part of the machinery in the old hull, which has been in use since 1912, will be used on the new boat.

Government Geologist Sees Good Chances in Quebec Gold Belt

Four Prospects Give Promise—Many Discoveries of Narrow Veins Show Mineralization to Be General

In a short review of recent developments in northwestern Quebec H. C. Cooke, of the Canadian Geological Survey, states that at least four orebodies have been discovered that seem likely to develop into producing mines. These are on the Chadbourne, Horne, Stabell, and Lake Fortune properties in Rouyn and Dubuisson townships.

On the Horne claim, four or five sulphide bodies have been found to date and partly explored by trenching; but there are indications that others occur. One body is reported to carry $7 to $10 in gold per ton and 5 per cent copper. The ore on which work is being pushed appears to be more than 50 ft. wide at the surface; the other dimensions are still unknown.

On the Chadbourne property, the rock has been replaced by heavy sulphides, as on the Horne, but, unlike the Horne, the sulphides are accompanied by considerable amounts of ordinary vein minerals such as quartz and calcite. Values obtained are promising.

The discovery on the Lake Fortune property was made several years ago. Work was renewed in 1923, and trenching has revealed some rich specimens of gold and tellurides. The ore lies in a belt of schist having a minimum width of 6 to 8 ft. At the southeast corner of Lake Fortune more or less quartz has been injected between the layers of schist and the whole is mineralized with free gold, gold-silver telluride, and sulphides.

The Stabell property lies in Dubuisson Township. It consists of a quartz vein 2 to 3 ft. wide, rather heavily mineralized with auriferous chalcopyrite.

Not the least important result of the season's prospecting is the discovery of gold at a great many other points, proving the auriferous character of a wide belt extending more than 100 miles east from the interprovincial boundary. Most of the veins found are too small or insufficiently rich to be of commercial importance, but their occurrence shows that the conditions favoring the formation of orebodies prevail throughout the belt, and holds out the reasonable expectation that with further search larger and more valuable deposits may be found.

Signal Mines Co. Plans Volatilization Plant in Arizona

The Signal Mines Co., operating at McCracken mountain, Mohave County, Ariz., may erect a plant for the reduction of its ores and concentrates, by the volatilization process. As the company intends to treat custom ores, this installation should prove a stimulus for the near-by lead properties, including the Red Top, Eaton, Lucky Strike, and Lead Bullion. Some of these properties have been shipping high-grade galena carrying about ½ oz. silver per unit of lead.

Shutdown of East Butte Smelter Seems Probable

The closing of the East Butte Company's smelter at Butte is likely to follow the consummation of the deal whereby the Anaconda company proposes to take over the Davis-Daly property for $3,000,000. The output of the Davis-Daly has heretofore been shipped to the East Butte smelter where it has formed an important part of the ore supply. When, and if, the Anaconda company takes over the Davis-Daly property the ore will no doubt go to the smelter at Anaconda.

It is rumored that the East Butte is already considering the closing of its smelter if the deal goes through, of which there does not seem to be any doubt. So far as labor is concerned, it will make little difference, as the miners and smeltermen will easily find all the work they want at other properties. It is said that the Colorado, of the Davis-Daly company, will be operated through Anaconda's Original shaft.

Mike Horse Mine Ships Lead-Zinc Concentrate in Montana

The Sterling Mining & Milling Co. has been shipping an accumulation of high-grade lead-zinc concentrate from its Mike Horse mine on the head of the Big Blackfoot River near Flesher, Mont. Approximately 400 tons has been brought over the main range during the last month, and will be followed by more than 200 tons of first-class ore. The company's mill is to be remodeled in the spring and adapted for the separation of the zinc and lead. The silver content runs ½ oz. to 1 per cent of lead. The stope from which the ore is mined is upward of 20 ft. between walls, the galena ore occurring in a calcite vein, in belt shales and diorite.

Bank Mining Co. Revives Sierra Pinta Gold Property

The old Sierra Pinta gold mine, situated 85 miles southwest of Ajo, Ariz., in the extreme northwestern corner of the State of Sonora, Mexico is being reopened. The property was last shut down about ten years ago. During the war the narrow-gage railroad connecting the mine with San Georges Bay, on the Gulf of California, was torn up and shipped away. For the last two years the Bank Mining Co., of Buffalo, N. Y. has been working upon the rehabilitation of the property.

The scarcity of water has been the most serious problem the company has had to contend with. This has been overcome by the construction of a pipe line nine miles long. A 40-ton cyanide plant for handling the ores which are free milling, will be ready for operation by July next. On account of the isolated location of this property it has attracted little attention, but the production record is known to be good and there is reported to be a considerable tonnage of $20 ore blocked out and ready for treatment. About seventy-five men are now working on the property.

Treadwell Interests Seek Lead Ore in British Columbia

Prince Rupert Possible Site for Smelter —Keno Hill Ore Would Have Shorter Haul

V. C. Clauson, manager of the Treadwell interests in Alaska, has been looking over the mines contiguous to the Grand Trunk Pacific Ry., for the purpose, it is stated, of finding how much ore they are likely to be able to provide toward supplying a smelter at Prince Rupert or some equally suitable site. The Treadwell interests own a number of properties at Keno Hill, Yukon. Last year, 4,000 tons of ore was shipped from these mines by sleds and tractors to the Stewart River, a distance of 40 miles, thence 200 miles down the Stewart, 500 miles down the Yukon, 200 miles up the Tanana to the railway; thence 400 miles by rail to tide-water, 1,100 miles by water, and finally 400 miles by rail to the Bunker Hill & Sullivan smelter at Kellogg. As will be evident, it takes pretty good ore to stand this treatment, and the company is contemplating rerouting it overland and by way of the White Pass Ry. to Skagway. If a smelter were erected at Prince Rupert it would cut out 600 miles of water and 400 miles of rail haulage. The difficulty is, however, that at present there is not sufficient ore coming from the Keno Hill camp to keep a smelter occupied, so, according to reports, Mr. Clauson is looking over the district contiguous to the G. T. P. Ry. to see what quantity of ore these mines are likely to be able to supply.

Arsenic Market May Reopen Old Montana Properties

Investigations of the Lee Mountain mine, at Rimini, Mont., and the Minah mine, near Wickes, are under way. Each mine had produced more than a million dollars, prior to 1893, from gold, silver, and lead; and in each there are known reserves of sulphide ores, rich in arsenic and gold, which were unprofitable in the early days when the arsenic was penalized by the smelters. This is characteristic of many of the silver-lead mines about the Boulder batholith. Under present conditions, particularly when arsenic is an asset, profitable operation may become again possible.

Carson Hill Will Use Diamond Drill and Stope Scraper

A diamond drill has been recently purchased by the Carson Hill Gold Mining Co. and put in operation at the mines of the company at Melones, Calif. It will be used in exploration. A scraper has also been installed for use in stoping operations. Diamond drilling has been rarely used by Mother Lode mining companies, and usually, whatever work of this kind was attempted, was done on contract. Scrapers cannot be used to advantage in most Mother Lode mines, but in the flat veins that have been discovered at Carson Hill is opportunity for their use.

Two Southern Illinois Fluorspar Mines, Flooded, Are Idle

Rosiclare and Fairview Suffer—Hillside Company Operates—New Properties Are Being Developed

The mines of the Rosiclare Lead & Fluorspar Co. at Rosiclare, Ill., were flooded recently, and all underground operations are at a standstill. The mines are flooded up to the 220 level. Water came in on the 700 level and flooded the pumps. A large tonnage of ore is broken down ready for hoisting in the lower levels. The Fairview Lead & Fluorspar mine, also is flooded and has not been operated underground for some months. The mines are situated on the Ohio River and have had trouble before with excessive water.

The Hillside Fluorspar mine, which is located on the Rosiclare vein and north of the Rosiclare property, is operating with a full force of men. The company leased the Indiana property last June and has done considerable work. Two shafts have been put down, one 100 and the other about 65 ft., both on a new vein with good grade of ore. Also, an adit has been driven under the hill from the north side, with ore running from 5 to 11 ft. wide.

W. J. Rodgers has leased the Dubois fluorspar property that joined the Indiana property on the southwest, and some prospecting has been done. Good ore has been found near some of the old prospect workings on this property, and plans are being made for further operations in the spring.

The Aluminum Ore Co. is negotiating for the property known as the Hamp mines, situated about 12 miles north of Elizabethtown, Ill. This property is noted for its high-grade fluorspar.

West End Consolidated Prospects Extension Ground

The West End Consolidated Mining Co., operating in the Tonopah, Nev., district, has entered into a working agreement with the West End Extension Mining Co., which owns ground west of the Tonopah "76" property. Actual development of the ground has been started. A crosscut from the 800 level of the Ohio shaft workings has crossed the property line and is now in West End Extension ground. The crosscut is said to be in Extension breccia and is being run at right angles to the strike of the Tonopah vein system. This territory is virgin and possibilities for important developments are considered to be very good.

Manson May Build Sampling Plant at Kingman, Ariz.

F. M. Manson, manager of the Western Ore Purchasing Co. of Reno, Nev., is considering the installation of a sampling plant at Kingman, Ariz., which will in a measure relieve the situation caused by the closing down of the Southwest Metals Co.'s smelting plant at Humboldt. A shipment has been made from the C. K. Copper mine, near Chloride. The ore is high-grade black copper oxide.

News from Washington

By PAUL WOOTON
Special Correspondent

Gold-Silver Commission Summarizes Problems of Non-Ferrous Metal Industry

Public Interest Requires Profitable Exploitation of Metal Wealth—Ore Reserves Comparatively Limited—Proper Balance Between Cost and Selling Price Needed

THE great importance to the nation as a whole of its non-ferrous metal reserves and the limited extent of these resources has been presented to the Senate of the United States in striking manner in the progress report of the Commission of Gold and Silver Inquiry. The commission declares that the industry as a whole finds it necessary, in order to avoid great loss from shutting down, to resort to uneconomic and wasteful selective mining. This tends to leave mines in such condition that the remaining metal-bearing material can never be mined under normal conditions, thereby resulting in a permanent loss of ore reserves. The report of the commission among other things says:

"The best interests of the nation demand that capital invested in the development of its natural resources create new wealth, and unless the proper relation between cost and selling price is restored the present conditions must inevitably result in the waste of invested capital, the loss of developed ore reserves, a loss of taxes, potential unemployment, low standards of wages, and an imperiling of national safety, by bringing nearer the time of dependence of the United States upon foreign metal supplies.

"The quantity of non-ferrous metal-bearing material known to exist in the metalliferous deposits of the United States is large, but because of increasing per capita consumption of these metals under normal conditions, the actual ore reserves are of very limited life. The total quantity of proved, probable, and possible reserves of the most abundant of the non-ferrous metals in the known deposits of the United States with a normal spread between cost and selling price is equivalent to no more than about a twenty-five-year supply and the least abundant to about a ten-year supply at the normal rates of consumption.

"The mining industry consists of a large number of individual and generally unassociated companies, each one of which is dependent upon the utilization of assets (ore reserves) of a limited and non-renewable or non-replaceable character; that is, dependent upon the extraction of ore from a de-

Problems of the Mining Industry as Seen by Senate Gold-Silver Commission

THE mining industry has so far outgrown the governmental machinery for maintaining sound conditions in the industry that a number of serious problems have been allowed to develop. The future welfare and national security of the United States depends to a large extent upon the solution of these problems, which may be enumerated as follows:

1. The high cost and inefficiency of labor and the immigration problem.

2. The great burden of federal, state, and local taxation.

3. The inability or the failure of mining companies to consolidate sufficiently to enable the industry more rapidly to adjust itself without loss to the extreme variations in demand.

4. The inability of the metal-mining industry of the United States to finance its exportable surplus and to carry the stocks of metals accumulated during periods of excess production or diminished markets.

5. The inability of American producers so to co-operate with American and foreign producers in foreign countries as to meet the foreign competition of the strongly organized foreign selling agencies and consumers.

6. The high cost of transportation.

7. The inability to secure for the metals a price comparable to the present general index of other commodities. At the present time the metals of the United States are being mined and sold in the main at prices which are so low that they will not purchase more than one-half to two-thirds of their equivalent worth in other commodities, as indicated by pre-war price relations, notwithstanding the fact that the cost of practically everything which is used in mining has risen comparably to the rise in the general index. This whole condition is entirely contrary to the best interests of national conservation and sound economics.

posit or deposits of very limited extent which are worthless when the ore is exhausted. In this respect the mining industry is entirely different from that of farming or even lumbering, since farming is based upon annually renewable crops and land of some permanent value and lumbering is based upon renewal forests.

"Mining companies differ from manufacturing companies in that the latter draw their raw materials from many sources and are not dependent upon the limited supply of raw material contained in a single or a few deposits. The mining industry differs from the transportation industry in that the latter draws its revenue from many sources, including agriculture, which provides an annually renewable tonnage.

"The quantity of ore reserves in any metalliferous deposit is dependent upon two factors, (1) the cost of production and (2) the selling price of the metal; that is, only such material as can be mined at a profit can be considered ore reserves.

"Therefore, ore reserves, to be ore reserves, must yield a certain minimum unit profit when mined which will (1) redeem the invested capital, (2) pay a return equal to that paid by investments of minimum risk, and, in addition, (3) compensate for the risk involved in a mining investment, and (4) compensate for or insure against a deference of dividends, or the industry is not being operated upon a sound basis, either from the point of view of sound economics or national conservation.

Ore Reserves May Vanish

"Consequently, whenever the spread between cost and selling price becomes less than the necessary minimum unit profit, such metalliferous material ceases to be reserves and the money invested in its development becomes a loss of capital. Therefore, if through any cause whatsoever the spread between cost and selling price becomes less than normal, there is a corresponding shrinkage or diminution of the known ore reserves of the nation. When the spread becomes zero or negative, ore reserves vanish completely.

"With the exception of the United States, all of the enterprising and progressive governments of the world, realizing their dependence upon the adequate supplies of the basic metals, are stimulating and encouraging the development of the mining industry within their boundaries, and are stimulating and encouraging the acquisition by their nationals of foreign deposits.

"With respect to the acquisition of foreign deposits, American interests have been safeguarded to some extent by the courage and enterprise of American capital which prior to the war acquired some important foreign deposits and thus prevented their control by foreign countries. Under the present conditions of the metal-mining industry, however, there is little inducement for American capital to undertake the risk of additional foreign mining investments.

"The American mining industry has already experienced serious competition and loss from foreign production which has been stimulated by the far-sighted policy of foreign governments, and the United States as a nation will suffer greater losses unless constructive domestic and foreign policies are developed which will enable our mining industry successfully to compete.

"Since ore reserves, regardless of how optimistically they may be calculated, must necessarily be limited, and since the per capita consumption of these metals under normal conditions is constantly increasing, it is fundamentally necessary, in order to maintain the present industrial independence, the prosperity, and the national security of the United States, that new ore reserves be developed to provide for the ever-increasing need and to take the place of those which are being exhausted. It is not reasonable to expect the development of these necessary additional ore reserves unless capital in large amounts is forthcoming, and it will not be forthcoming unless the mining industry is an attractive investment.

Algerian Phosphate Producer Rapidly Increases Output of Mines

Property in Province of Constantine—Improvement in Technical Practice and in Transportation Facilities Helps

Special Foreign Correspondence

One of the important sources of North Africa phosphates is the property being worked under the concession of the French Algerian Government by the Compagnie des Phosphates de Constantine. An increased capital was called for by the company in 1920, the results accruing from the use of which have been most satisfactory. Profits in 1919 were 1,500,000 francs; they reached 5,000,000 in 1921 and over 6,000,000 in the year just passed.

Output has been, in metric tons.

1919	209,770	1921	346,053
1920	289,588	1922	401,757

The output for 1923 it is stated will show a notable increase over that of the year before.

The organization forsees an output of 800,000 metric tons per annum within the next two or three years. The work of modernizing the plant and equipment is being carried forward rapidly (in anticipation of the great development of the Moroccan fields, it is to be presumed) and many improvements in technical processes are being adopted. At present mechanical mining equipment is being used, thus reducing the labor costs and increasing output.

Stocks are carried and handled by improved means at the Mediterranean shipping port of Bone, and loading facilities for steamers have been increased to 400 tons per hour. The narrow-gage line is being transformed to standard width from Tebessa and Souk-Ahras. Engineers are reinforcing bridges and culverts which were not intended for carrying of heavy loads. When these improvements are completed the movement from the mines to port will be greatly facilitated. There are already in service 200 automatic dump cars carrying twenty tons each.

Projects to Revive Queensland Gold Fields Are Under Way

Cairns Syndicate Leases Properties in Palmer Field—Another Is Batavia River Diggings

By Our Special Correspondent for Queensland, Australia

Brisbane, Jan. 10—Special attention is once more being directed to the old Palmer gold field, as well as to the remote Cape York Peninsula generally, of which the Palmer forms a part. The Palmer field, in the early days before Queensland was a separate state, gave almost wonderful gold returns for several years, first from the alluvial, or placer, deposits, and afterward from reef mining down to a comparative shallow depth. Then water difficulties were encountered, and these soon became too great to be overcome by the miners of limited capital and with the primitive appliances which were at that time available.

An attempt to revive the district is being made by a Cairns syndicate, who have leases, under special conditions, covering three old mines. This syndicate has just started operations. They are getting the water out of one of the mines (the Louisa), and are providing a crushing plant at an adjoining one, hoping to have this ready for use by the time the Louisa is producting. The Louisa was unwatered by the government a year or so ago, and the lower levels were tested, with what were considered satisfactory results, but the mine subsequently became flooded without being worked.

In the more northern part of the Cape York Peninsula is an old alluvial mining camp known as the Batavia River Diggings, which is nearly as old as the Palmer. The position of this field is only about 200 miles south of Cape York, the northeastern extremity of Queensland and of Australia. One portion of the field was discovered by an aboriginal. Recently there was quite a "rush" to this field, and already the number of miners on the spot has increased from eight to a hundred, three-fourths of whom are on gold, and some of them are doing very well.

The only company now operating on the old Ravenswood gold field is the Ravenswood Gold Mines, Ltd., which holds leases covering the ground of the Grant mine, which was a noted producer a number of years ago. This company has for some time been getting good returns. The last crushing was seventy-five tons, which gave the excellent yield of 212½ oz., and from another crushing the same quantity of stone yielded 150 oz. The deepest workings are 520 ft., where the leading stope carries 4 ft. of ore of good quality. In other parts of the mine the reef is from 7 in. to 8 in. thick.

On the Kangaroo Hills tin field production is still being retarded by a scarcity of water. The Sardine mine has reached its last crushing until rain falls to replenish the battery supply. This crushing was forty-five tons, the return from which was seven tons of black tin, or about 15½ per cent. This is only about half the value of crushings from this mine in the first two years' of its existence, but fresh rich veins may be met with at any time.

Fujita Mining Co. Runs Copper Smelter at Part Capacity

Japanese Company Plans Purchase of New Gold Quartz Mine—Takatama Gold Mine Active

By Hironao Nishihara

The Kosaka copper mine and smelter, of the Fujita Mining Co. is not producing more than seventy-five tons a day at present. The ore comes mostly from the Hanaoka mine, where a large orebody in the Kuromono has been discovered. The orebody lies under the cover of pumice, conglomerate, and clay of between 70 and 300 ft. in thickness. The smelting of the copper ore alone is not generally considered to be profitable under the present market conditions, and the company is reported to be considering the purchase of a quartz-gold mine in Hokkaido. In spite of the flat-lying extensive orebody with overburden of soft material, the ore is now being mined by underground methods. By this system not over half of the ore can be extracted. In some raises and winzes the temperature is above 100 deg. This makes difficult mining, besides creating the danger that the entire mine may be set afire on account of the pyrite. The orebody is ideal in every respect for open-pit working by steam shovel.

The Takatama gold mine, of the Kuhara Mining Co. is active. There are more than 350 known veins in an intensely silicified Tertiary shale and tuff. The north-south veins dip steeply west, and the east-west veins dip steeply north. The width of the vein varies from a few inches up to 3 ft., but on an average does not exceed 6 in. This means that the mine should make nearly 30,000 ft. of advance monthly in order to output sufficient to meet the demand of the smelter at Hitachi. The presence of adularia in large crystals in the vein has attracted much attention of geochemists and is now being investigated by the members of the Tohoku University, of Sendai.

The Taio gold mine has been making a record production and is now reported to be producing over $60,000 in gold and silver monthly.

Flooding of Mine at Crosby, Minn., Costs Forty-two Lives

Flooding of the Milford mine of the Whitemarsh Mining Co. at Crosby, Minn., by water from a small lake under which the workings extended, caused the death of forty-two of forty-nine miners who were at work in the mine on Feb. 3. The water entering through the caved back of the main level drift rose 150 ft. to the collar of the shaft in twenty minutes. The workmen were thus without means of escape, and were suffocated by the mud and water.

There was no extended warning; just a "rumble like a thousand automobiles roaring down a distant road," one survivor said. Most of the victims were young men, many of them married.

During the last year, the mine had yielded about 70,000 tons of manganese ore.

Mammoth Plaster & Cement Co. Contracts Gypsum Shipments

The Mammoth Plaster & Cement Co. of Cedar City, Utah, is understood to have signed a contract with a California firm for the delivery of a fixed tonnage of raw gypsum—200 to 300 tons daily—for a year from gypsum mine owned by the company. The gypsum is high-grade. A trial shipment of eighteen tons sent out recently is said to have proved satisfactory. There is an immense tonnage of the material available.

Cariboo Placer Boom Failed to Materialize in 1923

No New Producers—Much Prospecting, Some Development, and a Little Production

By Donald D. Fraser

Although none of the new projects that are being promoted in the Cariboo placer district, in British Columbia, reached a producing stage during the past season, development was active and a number of old producers were in operation.

Placer operations of the Perkins Gulch Mining Co. in the Cariboo district, B. C.

License Law Aims to Stop High-grading in Ontario

In an effort to curb "high-grading" and the illegal dealings in precious metals, a bill is to be introduced in the Ontario Legislature requiring all persons or firms buying or selling precious metals to take out a license. Under this licensees will be required to report monthly to the government all transactions in unworked precious metals, with the names and addresses of the purchasers or vendors. Infractions will be considered a serious offense. This bill is being fathered by the Canadian Manufacturing Jewelers' Association, some of whose members nearly got into trouble through the innocent purchase of gold of questionable ownership, and it is also approved by the Ontario Mining Association, which represents practically all of the producing mines of the province.

Fremont Mine, at Sutter Creek, Calif., Shuts Down

The Fremont Mining Co., operating at Sutter Creek, Calif., has temporarily closed down. The mine was financed by Edwin Higgins and his associates, and mining and milling operations were started. Efforts to further finance the property have not been successful, and operations have been suspended pending the securing of additional capital. The mine produces gold ore.

For some years the Hopp mines have been the most steady producers of the district. Lowhee, the largest of the group, is said to have yielded $20,000 last season. No advance was made in the pit. For some years the flume has not been able to pick up the bedrock. The recent work done was to take up a considerable length of flume from the head of the sluice and pipe back toward the face, relaying the flume on a lesser grade. The clean-up was therefore gold which had been passed by during the last few years.

The Perkins Gulch Mining Co. operated its small plant only and was unable to bottom its pit for lack of water. The Kitchner mine, at Keithley, operated, but the results are not known. At the Catch, four miles from Barkerville, the Houser brothers cleaned up about $3,000 from their small hydraulic pit. This appears to be a promising piece of ground.

Cedar Creek, which should have greatly swelled the production of the district in 1923, was idle most of the season. The main proven area was secured by the Cedar Creek Mining Co. on an agreement with the stakers, whereby the stakers, six in number, received 75 per cent of the clean-ups until the purchase price of $180,000 was paid. From all accounts this company mismanaged the work. A large crew was kept on the payroll with no work for them to do. Someone commented to the manager on the inefficiency of the work, and the manager replied that the ground was so rich

that it did not matter what they did. The resident engineer of the district estimated that the ground worked averaged $50 to $60 to the cubic yard and some of it went as high as $200. This company recovered more than $200,000, but was finally forced into the hands of a receiver. The receiver carried on operations for a while, but eventually the title lapsed to the stakers, who are now again trying to promote a company.

The Lightning Creek Gold Gravels & Drainage Co. made a slight noise in the district for a few months, but is now rather quiet. The company controls more than 20 miles of Lower Lightning Creek and has been spending money on it for as many years. It claims a paid-up capitalization of over $1,500,000, which is rather large for drift placer mine. To date, the property has not produced gold in any quantity. Some time ago the company went into the hands of a receiver. C. H. Unversagt is the prime mover of the company.

The Tertiary Mine, Ltd., is a new partnership formed to take over the holdings of the Tertiary Mining Co., Ltd., which consist of a deposit of moderately cemented gravel and a plant for treating the gravel. The new owners are making over the surface plant. It is hoped with the use of underground slushers to mine and treat the gravel for $1 a ton.

Wasatch Mines Co. Seeks to Reorganize in Utah

The Wasatch Mines Co. of Alta, Utah, which has been in the hands of a receiver, is seeking to bring order into its affairs. It may evolve some plan to satisfy its creditors, and secure a dismissal of the receivership, or incorporate a new company with a capitalization equal to that of the present company, offered to stockholders share for share, with a possible additional payment of 20c. a share. Another possible way out would be to make the stock assessable.

In past years, the company financed its development work through funds obtained by the sale of power developed by its power-plant at the mouth of the Wasatch tunnel. Through a recent court decision, the mining company lost the use of the surplus water, and with it an important source of income. The Wasatch Mines has undertaken a long and expensive work in driving the tunnel to open at greater depth the downward extension of the old Columbus orebodies, abandoned at the 400 level, on account of excessive water.

Electric Locomotives as Well as Shovels at Wabigon Mine

The Hanna Ore Mining Co. has decided completely to electrify its Wabigon open pit on the Mesabi iron range at Buhl, Minn. At present the company is operating a 300-ton Marion electric shovel in removal of the overburden. It now contemplates replacing the present steam-operated locomotives with three 60-ton electric locomotives. On completion of this work in the early part of this summer, the Wabigon pit will be the first completely electrified one in the Lake Superior district. The results of this new system of surface haulage will be watched with great interest on the different ranges as electric power is becoming easily accessible for all properties, owing to the consolidation and expansion of the electric companies in this district.

Ohimo Mine, in Picher, Purchased by Bendelari Interests

The Grace B. Mining Co. has purchased the Ohimo mine in Picher, Okla., from the Bilharz estate and others, at a reported consideration of $52,500. A. E. Bendelari and associates compose the Grace B. The Ohimo mine is located just west of the La Salle mine, which also is owned by Bendelari and associates. It has been a steady producer for a number of years, and has been operated since the first of the year by the Grace B company. It is equipped with a large concentrator, being capable of handling 500 tons of ore in a ten-hour shift.

Santa Gertrudis mine at Pachuca, Mex.

Would Find Better Basis for Appraising Iron Ore

An effort is being made by the U. S. Bureau of Mines to work out a better method of determining the relative worth of the different grades of iron ore. An invitation just has been issued to the Lake Superior Iron Ore Association to appoint a committee to cooperate in this study. A more nearly correct basis of valuation is made the more necessary because of inequitable tax collections when based on a value determined by the iron content alone. The actual value of ore depends upon factors other than iron content. Ores containing the same amount of iron, for instance, may vary greatly in value because of a variation in their silica content.

Hammon Consolidated Will Build New Dredge at Nome

The Hammon Consolidated Gold Fields at Nome, Alaska, will operate three dredges during the season of 1924 and will construct another dredge of the same size and design as the two 9-cu.ft. dredges constructed at Nome during the winter of 1922-23. Both of these dredges have had a successful season, and thawing operations have been developed until they are efficient and satisfactory. By reconditioning an old dredge, a third boat will be put in operation when the season opens. The fourth dredge to be constructed by the Yuba Construction Co. will be completed and put into operation during the season. Two additional 525-hp. Werkspoor Diesel engines and generators will be added to the power plant, making the total installed 2,100 hp.

Miners with $8,000 Wage Claims Sue Tidewater Copper Co.

Miners who worked for the Tidewater Copper Co. and were paid off at the end of November by checks that the bank on which they were drawn refused to honor are starting action against the company, and may force it into liquidation. The total amount of wages due is about $8,000. The mine and plant are valued at a million dollars.

Mabel Mine Ships Car of $125 Ore from Mina

A car of ore was shipped from the Mabel mine, near Mina, Nev., operated by the West End Consolidated Mining Co., on Jan. 26. The ore will run over $125 per ton in gold, silver, and lead. It has been reported that the oreshoot developed on the upper levels has been cut on the 400, or bottom, level, and the drift is in ore of good grade, driving westerly. The west drift entered ore at about 150 ft. from the shaft, indicating a stronger rake to the west than previously believed. A hanging wall crosscut has been started from the 300 drift to prospect for other veins which were productive on upper levels, but which have not been developed at all on either the 300 or 400 levels as yet.

Societies, Addresses, and Reports

Preparedness Theme at Dinner of New York Engineers

National Societies Meet Under Auspices of Army Ordnance Association at Hotel Commodore

Industrial preparedness for a possible war was the subject which attracted over 700 engineers to a dinner given at the Hotel Commodore, in New York, on Feb. 5, under the auspices of the Army Ordnance Association and five national engineering societies, including the A.I.M.E. Judge Elbert H. Gary presided, the other speakers being Col. Dwight F. Davis, assistant secretary of war; Col. James L. Walsh, chief of the New York Ordnance District, and General John J. Carty, of the American Telephone & Telegraph Co.

Colonel Davis explained that work on industrial mobilization has been under way for three years and much progress has been made. The seven supply branches of the government have figured out what will be required should the country find it advisable to engage in war, and the next question that arose was where can the necessary supplies be obtained. To answer this a survey of the industrial resources of the country is in progress. "We seek only one end, our national security," Colonel Davis said. "We must remember national preparedness today means not only trained man power, but supplies and equipment with which the army can fight." The final goal of the planning work will be that upon the receipt of a telegram from the War Department, every manufacturer who is to do war work will go to his safe, take out his production schedules, plans, specifications, and contracts and immediately begin to work as arranged.

General Carty read an address in which he paid a tribute to the part played by American engineers in the last war, and emphasized the necessity of being better prepared for the next one. He said that a general legal form on which contracts for the manufacture of munitions would be made has been prepared by War Department officials and is available for consideration by industrial managers.

In an anteroom to the banquet hall was an exhibit of modern developments in munitions, including a 4,000-lb. aerial bomb, ten times the weight of the largest bomb used in the World War. Designed to be dropped from a Martin bombing plane, it contains 2,000 lb. of high explosives, and is capable of making craters 150 ft. in diameter and 50 or 60 ft. deep. This and other new inventions were described by Colonel Walsh, including a caterpillar tractor that will climb a 45-deg. slope at the rate of 30 miles an hour.

Colonel Walsh recommended complete arrangements being made for the manufacture of munitions on a war time scale, so that if there were any springing to arms overnight there would be arms to spring to. He also urged that engineers aid by forming local committees whose chairmen would comprise a district advisory committee.

Birmingham District Chosen for Fall Meeting of A. I. M. E.

Committee of Arrangements Headed by J. L. Davidson Now Making Preparations

Birmingham has been selected by the American Institute of Mining and Metallurgical Engineers as the place for the fall meeting this year. The exact date of the convention has not been announced. A Birmingham committee headed by James L. Davidson, secretary of the Alabama Mining Institute, has been appointed and is already at work making arrangements for the convention.

M.M.S.A. and A.I.M.E. Will Hold Joint Meeting

A joint meeting of the Mining and Metallurgical Society of America and the American Institute of Mining and Metallurgical Engineers will be held in the auditorium of the Engineering Societies Building, 29 West 39th St., New York, at 2 p.m. on Feb. 20, 1924. The chairman will be B. Britton Gottsberger. "Engineering Opportunities" will be the subject for discussion at the meeting.

Chinese Engineers Dine

Word from Peking dated Dec. 24 states that the China Institution of Mining and Metallurgy held its annual dinner there on Dec. 21. J. P. Kenrick occupied the chair. Amadeus Grabau, of the Chinese Geological Survey, spoke on "The Mining and Metallurgical Industry in China." He expressed his belief that future progress in geological research in China would be rapid. Capt. W. F. Collins another speaker, had for his subject "Kindred Societies in China." The mining industry in China, in its various branches was well represented by those present.

Purchasing Agents to Meet

The ninth annual convention of the National Association of Purchasing Agents will be held in Boston during the week of May 19.

British Mining Congress Set for June

An Empire Mining and Metallurgical Congress will be held in London, England, June 3-6, 1924, in connection with the British Empire Exposition. The congress has for its chief objects:

The discussion of papers on scientific, technical, and economic problems connected with the development of the mineral resources of the empire, and the mining and metallurgical industries.

The constitution of an Empire Council of Mining and Metallurgical Engineering Institutions, whose principal functions would be to serve as an organ of intercommunication between the cooperating institutions, and to promote the interests of the professions and industries; to create and maintain throughout the empire a high standard of technical efficiency and professional status; to convene successive congresses within the empire; and to establish, if necessary or desirable, a register of British mining and metallurgical engineers. Viscount Long of Wraxall will preside.

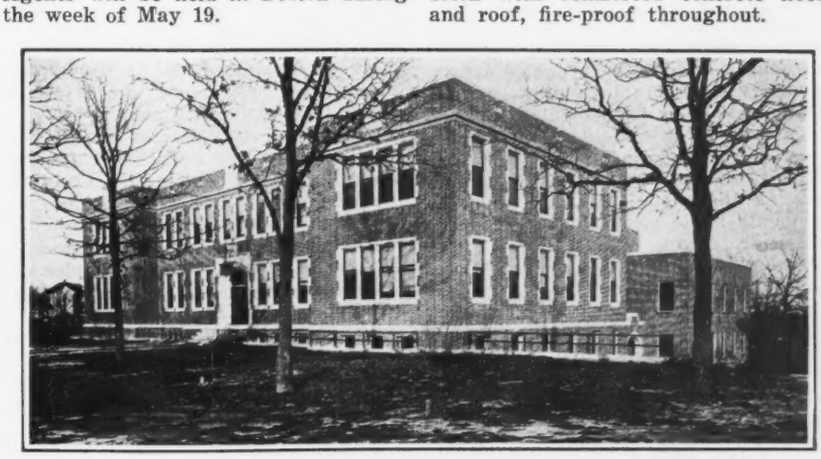
Favor Tax Reduction

Resolutions endorsing the Mellon tax reduction bill and opposing any changes in the National Transportation Act of 1920 were passed by the California Metal and Mineral Producers' Association at a meeting on Jan. 29 in San Francisco.

New Experiment Station Ready at Rolla, Mo.

The experiment station building which was provided for by the Missouri Legislature in 1920 to house the Mississippi Valley Experiment Station of the U. S. Bureau of Mines and the Missouri State Mining Experiment Station has been completed. The offices have been occupied and equipment is now being installed in the laboratories. The work to be done will consist of investigation into the mining and reduction of lead and zinc ores.

The building stands on the campus of the Missouri School of Mines and Metallurgy at Rolla, Mo., and was erected at a cost of $125,000. It is of brick with reinforced concrete floors and roof, fire-proof throughout.



New quarters of Mississippi Valley Experiment Station, U. S. Bureau of Mines, Rolla, Mo.

Recent Technical Publications

Reviews, Abstracts, and References

Determining the Value of Mineral in a Mine

Mineral Valuation. By Henry Louis. Charles Griffin & Co., Ltd., London. Price 15 shillings.

This is a treatise on methods of valuation of mines and other mineral properties. After a short discussion of the different classes of title to mineral deposits (mainly applicable to England) and a short description of ore deposits, which, logically enough for his purpose, the author classifies on a morphological basis (Chapters I and II), two long chapters are devoted to "Data for Valuation." These not only include discussion of the usual items involved in the problem, such as sampling, ore reserves, development and operating costs, and realization, but also the application of the principles of probability and the laws of error to the results. Chapter V is devoted to the derivation of formulas for determination of present value under a wide range of assumptions as to conditions, and Chapter VI shows the application of the principles and formulas previously discussed to five hypothetical mineral properties. Chapter VII discusses certain special cases requiring the services of the valuer and there is finally appended a Synoptic Table of the formulas worked out in the body of the text. No tables of Present Value such as are usually found in books on valuation are given, because, as the author says—"there are plenty of good Actuarial Tables available" and furthermore it is "impossible to provide tables corresponding to all rates of interest."

This statement in the preface gives some clew to the principal features of the author's treatment of his subject, which seems to accentuate unduly the mathematical side. Where the data on which the valuation of a mine is based are admittedly so approximate, it seems a mistake to deal in interest rates expressed in fractions of 1 per cent. The author, indeed, expresses some such opinion in the preface, where, in recommending the use of five-figure logarithms, he says: "When the data upon which a valuation is based are always necessarily affected by probable errors, generally considerable and often very large, meticulous refinement in precise calculation is absolutely useless and a sheer waste of time." It is true that these fractional rates result from calculating the annual rate equivalent to payments made semiannually or quarterly, or, again, from deducting the probable income tax. Nevertheless, such extreme accuracy seems out of place in these problems, and is to be deprecated as giving a false idea of the exactitude of the final result. On the other hand, the completeness of the discussion and the numberless contingencies provided for in the formulas are unquestionably valuable to the student of the subject.

The discussion of probable errors in averaging results is also interesting as indicating the effect of unusual values on the average. There is, besides, a discussion with mathematical demonstration of the error in the usual practice of averaging samples on the assumption that values and widths vary uniformly between contiguous samples. Both these discussions are useful in affording further basis for what is already realized—namely, that even the most approved and careful methods of sampling can give at best a result which is only an approximation to the truth and which requires for its application the judgment acquired only by experience. It is a well-recognized fact that, due to various causes which cannot be discussed here, actual mining rarely comes up to the expectation resulting from rigid interpretation of the sampling. Some modification must be made, depending on regularity of values and widths, character of ground, and other factors. With the necessary introduction of this personal equation, it appears an ultra refinement to figure averages by calculus. Extreme mathematical refinement is useless, the practical limit being the calculation of averages by the method which Professor Louis designates as the Witwatersrand—i. e., giving each sample assay a weight in proportion to the width it represents. As Hoover says: "The factors which must remain unknown necessarily lead the engineer to the provision of a margin of safety which makes mathematical refinement and algebraic formulae ridiculous."

The principles of the practical operation of sampling as set forth in the book are generally sound. Occasionally, the views of others are given, as, for example, where the author, after describing a method of sampling by pop shots, states that some engineers are opposed to this method (with whom the reviewer would include himself). There are good discussions of other very pertinent considerations, such as the amount of coal to be left to support the surface, subsidence, losses in working, and on the financial side description is given of various kinds of royalties and other charges necessary to take into account. Some of these, familiar enough no doubt to English mining engineers, sound like a foreign language to American ears.

In the five examples of application, the conditions and data for valuation, and the resulting calculations, are given in full detail. Under the conditions assumed in some of the examples, the methods used are open to criticism. To illustrate, one of the examples describes a property traversed for about 1,500 meters by the outcrop of a tin lode. Eleven samples have been taken, six of which have been cut from shallow surface openings, four from underground workings which attain a depth of about twenty meters, and one from a short adit which attains a depth of a meter or so. The average width of the vein is taken as the arithmetical average of the widths of these eleven samples, which is correct procedure to the extent that eleven measurements in a length of 1,500 meters can give reliable information of such a variable as the width of a vein. The average assay, however, is not calculated by what the author has previously commended as the Witwatersrand method. No consideration is given to the width represented by the assay, but an artificial weighting is used, on the ground that samples taken below the surface should have twice the weight of those from the surface. Whether the observed character of the ore warrants such an assumption or not, the correct average could be determined only by weighting the assays finally according to the widths represented. Similar procedure in the valuation of a hypothetical gold mine, the next example, is subject to the same criticism.

The book is well made, the proofreading accurate, and to the experienced engineer the work will be found interesting, particularly on the mathematical side. ALLEN H. ROGERS.

Index of Geological Literature

Catalogue of Published Bibliographies in Geology. Compiled by Edward B. Mathews. Bull. National Research Council, Washington, D. C., Vol. VI, Part 5, October, 1923, No. 36. Price, $2.50.

A bibliography of bibliographies in geology, amounting to 210 pages and acknowledged by the author as not necessarily complete ("there must be many omissions of bibliographies of foreign origin") emphasizes the great sea of scientific literature which has accumulated. For the investigator it is an uncharted or a poorly charted sea. Dr. Mathews is an explorer, a systematizer, and a maker of charts for this ocean; and as such must be blessed by all navigators to come. It is an arduous and not sufficiently rewarded job to compile a bibliography: therefore let us at least not forget to thank Dr. Mathews and the National Research Council, and to testify that a great service has been rendered.

J. E. SPURR.

Copper Leaching—"Ferric Sulphate and Sulphuric Acid from Sulphur Dioxide and Air" is discussed in U. S. Bureau of Mines *Reports of Investigations*, Serial No. 2,556, obtainable on request from the Bureau at Washington, D. C. The paper, which is of 5 pages, presents a summary of the work done at the Southwest station of the Bureau and by some other experimenters and indicates the importance of a study of the subject by those interested in the leaching of copper ore.

Solubility of Rock Dust—The "Solubility of Finely Divided Rock Dusts in Water, Kerosene, and Alcohol" is discussed in U. S. Bureau of Mines *Reports of Investigations* No. 2,548, 6 pages, obtainable on request from the Bureau at Washington, D. C. This subject is one of importance as affecting the accuracy of dust sampling.

MEN YOU SHOULD KNOW ABOUT

W. H. Wiley has been in Tonopah on professional business.

Charles E. Knox, president and manager for the Montana Tonopah Mining Co., has recently been in Tonopah.

Francis R. Pyne is now assistant general superintendent for the Nichols Copper Co., at Laurel Hill, N. Y.

Colonel H. H. Stout has been in the West for some time, but expects to return to New York early in March.

Clyde A. Heller, president of the Tonopah Belmont Development, Co., has been in Reno and Tonopah from Philadelphia.

H. P. Henderson, consulting engineer of New York, is in Tonopah on geological work for the Tonopah Belmont Development Co.

R. F. Baker, of Houston, Tex., has been advanced to chief geologist of the Texas Company. Mr. Baker was formerly assistant geologist.

Frank M. Manson, manager for the Western Ore Purchasing Co., has returned to Reno from a business trip through California and Arizona.

C. P. McCormack, consulting mining engineer to Crowell & Murray, of Cleveland, Ohio, is going to the Michigan iron country on consulting work.

L. C. Moore has been elected president, **W. A. McCurdy** vice-president, and **George Martin** secretary, of the Engineers' Club of Northern Minnesota.

T. W. Vaughan, long with the U. S. Geological Survey, has gone to La Jolla, Calif., where he will enter on duty as the director of the Scripps Institution.

N. M. Bullock, of Rockdale, Tex., has been appointed to the position of State Mine Inspector to fill the vacancy caused by the resignation of **Bruce Gentry,** also of Rockdale.

E. A. Strong, until recently superintendent for the Belle-Helen Merger Mines Co., operating at Belle-Helen, Nev., has gone to San Francisco from his Tonopah headquarters.

John Dynan, mine superintendent for the Tonopah Extension Mining Co., was recently operated on for acute appendicitis. His condition is satisfactory and an early recovery is anticipated.

B. B. Hood, who was assistant works superintendent of the U. S. Metals Refining Co., is acting as works engineer at the new plant which the Western Electric Co. is building at Kearny, N. J.

H. C. Parmelee, editor of *Chemical and Metallurgical Engineering,* on Feb. 8 gave an address at Carnegie Institute of Technology, Pittsburgh, on "The Relation of Chemical Equipment to Pittsburgh Industries."

A. E. Lowe, general manager for the North Star Tunnel & Development Co., which has closed its Tonopah properties and begun development of a property in Grass Valley district, has been in Tonopah on a business trip.

Lieut. Ernest W. Ellis was recently appointed instructor in mining and metallurgy, and assistant metallurgist in the Idaho Bureau of Mines and Geology. He succeeds **C. B. Marshall.**

L. H. Owen, consulting engineer and geologist, has again opened an office in the Worth Building, Fort Worth. Tex. For several months Mr. Owen has been in charge of producing oil properties in Arkansas fields.

Alfred C. Bierman, geologist and consulting engineer, has opened an office in the Southern Life Insurance Building, Dallas, Tex. Mr. Bierman is associated with **Clarence B. Osborne,** Security Building, Los Angeles, Calif.

John E. Hodge, formerly vice-president of the E. J. Longyear Co., of Minneapolis, has formed the General

John E. Hodge

Securities Finance Co., with offices at 510 Consolidated Building, Los Angeles, Calif.

Spencer Penrose, mining engineer and capitalist, and largely through whose efforts the Utah Copper Co. was organized, sailed on the French liner "Paris" on Feb. 6 for Algiers and other parts of North Africa. Mrs. Penrose accompanied him.

James Taylor Kemp has resigned as metallurgist for the International Nickel Co. of Canada, Ltd., at Port Colborne, Ontario, to take a position in the metallurgical department of the American Brass Co. at Waterbury, Conn.

Harry J. Kelly, for thirty-five years general superintendent of the Bethlehem Steel Co., has been appointed general manager of the British Empire Steel Corporation and will have charge of all the steel operations of the company.

Dorsey Lyon, of Washington, D. C., assistant director of the Bureau of Mines; **Dr. T. T. Read,** Duluth, supervising engineer, and **E. W. Davis,** Minneapolis, superintendent of the Bureau's Minnesota experimental station, recently made a short trip to Birmingham, Ala., in connection with special work for the Bureau.

L. F. Rains, D. H. Botchford, S. A. Kennedy, Duncan MacVichie, and **W. R. Phibbs,** of the Columbus Steel Corporation, left Salt Lake City on Jan. 15 for a trip of inspection to the company's mines at Iron Springs, Utah. Mr. Phibbs is the superintendent in charge of the company's plant halfway between Provo and Springville and 50 miles south of Salt Lake City.

Dr. H. W. Gillette has been appointed chief metallurgist of the Bureau of Standards, to succeed **G. K. Burgess,** who recently was promoted to the directorship. Dr. Gillette for a number of years has been engaged in work on alloys at the Ithaca station of the Bureau of Mines.

Dr. L. D. Ricketts, president of the Inspiration Consolidated Copper Co. and past president of the American Institute of Mining and Metallurgical Engineers, was selected by the Arizona Industrial Congress to represent the mining interests at the meeting of its directors at Phoenix, on Jan. 10. In an address before the meeting, Dr. Ricketts discussed the condition of the copper-mining industry in Arizona at this time and pointed out the relationship of the various industries of the state and their dependability on one another.

OBITUARY

Edwin Ludlow

Edwin Ludlow died at Muskogee, Okla., on Feb. 10, 1924, after a brief illness. Mr. Ludlow was born at Oakdale, N. Y., in 1858, the son of William Handy and Louise Nicoll Ludlow. He was graduated from the Columbia School of Mines in the class of 1879, devoting his professional activities thereafter to coal mining, generally as an operating executive, being known in Pennsylvania, on account of his youth when assuming responsible executive positions, as the "baby superintendent." He was married to Anna Wright, of Oklahoma, on Nov. 22, 1893. After many years pioneer work in the West and in Mexico, Mr. Ludlow was in 1911 made vice-president and general manager of the New River Collieries Co., and a year later was chosen as vice-president of the Lehigh Coal & Navigation Co. and placed in charge of its mines. He remained with the Lehigh company until July 1, 1919, when he resigned to enter practice as a consulting engineer in New York City. On Feb. 15, 1921, Mr. Ludlow was elected president of the A.I.M.E. at its 123d meeting held in New York City. On that occasion he delivered a notable address, in the course of which he emphasized his conviction that upon the engineer rests in a large degree the responsibility for the great work of reconstruction following the war. Mr. Ludlow was a member of the Century, University, Columbia University, and Down Town clubs in New York, and of the Camp Fire Club. Burial was in Greenwood Chapel, New York, on Feb. 14. A biographical appreciation of Mr. Ludlow will be found on page 350 of *Engineering and Mining Journal* of Feb. 19, 1921.

New Machinery and Inventions

Use of Aluminum in the Shop Steadily Expanding

Forged Alloys Open Up New Field—Combination of Strength and Machining Qualities Valuable

Recent developments in the aluminum industry have not been startling, but have been deeply interesting to the metallurgical profession, owing to the ever widening application of this comparatively new metal. Great attention has been devoted to the development of strong alloys, these having now established themselves on a commercial plane. The "Shenandoah," the Navy Department's great airship, which recently made a cruise over the eastern part of the United States, and which was subjected to an unusually severe test when she was torn from her moorings in a recent storm, returning safely, affords a striking evidence of the utility of the strong aluminum alloy. The framework and metallic parts of this ship were practically all made of 17S alloy, so-called, manufactured by the Aluminum Company of America.

Automobiles are adopting forged aluminum alloys for connecting rods. These have already shown themselves adequate in several popular makes of cars, and it would appear to be only a matter of time when all the better cars will use forged aluminum connecting rods. The propellers of the airplanes which during the summer of 1923 have broken all speed records were made of forged aluminum alloy. A striking example of the marvelous toughness of this material is found in the instance where a plane fell on its nose, bending one blade of the propeller in the form of a C, without evidence of rupture in the metal.

Another field which has been opened up rather widely by the new alloys is that of automatic screw machine products. The combination of strength and machining qualities has never been met sufficiently heretofore to give great scope to this opportunity. From the products being turned out by manufacturers, however, it is evident that automatic screw machine products of aluminum alloys are going to find wide use, both for decorative purposes and where utility controls.

In aluminum castings the interesting work of the year 1923 lies principally with the die castings and permanent mold castings. Aluminum lends itself peculiarly well to the manufacture of such castings, and a great many of them are being made in such perfection that the consumer can apply the casting as it comes from the mold to the finished machine without touching it with a tool. The possibilities of economy are tremendous on this account. The vast demand for small electrical apparatus, into which such a great number of fabricated parts enter, opens up unlimited possibilities for these beautiful, white, perfect castings.

It is, however, in aluminum paint that some of the most interesting developments are being shown. This has always been regarded as a valuable metallic paint where its decorative qualities were appropriate. It appears, however, that this is the smallest value of aluminum paint. Its protective qualities have occupied a secondary consideration until the last year or so, but the manufacturers of this paint are claiming so many advantages for it as a protective paint that undoubtedly its use will be greatly multiplied. It is wholly opaque and possesses a high reflectivity, rendering it thus particularly suitable for such purposes as painting oil tanks, thereby minimizing volatilization, and is equally suited for interiors where greater light distribution is of value and at the same time protective qualities are required. Machine shops, forge plants, and any foundry building where iron parts are exposed to smoke fumes, if painted with aluminum paint, increase greatly the lightness of the building and insure excellent protection. It is, furthermore, true that the flowing qualities of aluminum paint are such that it goes farther than a corresponding volume of many other paints. The ease with which it can be prepared for application should make it popular with the amateur painter.

Screen with Flat-wearing Surface Developed

A new type of screen, suitable for use in stamp and roller mills, trommels and wherever separation is practiced,

Enlarged section of double-lock screen

has been developed by the Manganese Steel Forge Co., Richmond St. and Erie Ave., Philadelphia, Pa. The feature of this is seen in the flat-wearing surface, insured by the use of rods or wire having a short and deep crimp, which receives the entire depth of the crossing rods in both directions, as shown in the accompanying cut. The original shape of the openings is maintained throughout the life of the screen. The crimping being all on one side, the wearing surface is flat, thus insuring less resistance and longer life.

The Rol - Man double-lock mesh screens, as they are called, are made in all shapes—flat, or rolled to circles or segments. The size of opening varies from 3 mesh to 8 in., square or rectangular. They can also be furnished in commercial steel or acid-resisting metals.

It is claimed by the manufacturer that this screen will handle 10 to 25 per cent more product than plate screen, but that it has enough roughness to keep the material turning over in trommels. There is also more metal available for wear than in ordinary screens.

Car Puller a Plant Convenience

An electric capstan car puller made by the Silent Hoist Co., 302-4 McDougal St., Brooklyn, N. Y., is described in a leaflet issued by the company. It has a draw-bar pull of 5,000 lb. at 25 ft. per minute and consists of a Silent Hoist vertical capstan winch driven by an electric motor, mounted on a steel base. The capstan has a self-locking, non-reversible, worm-gear drive consisting of a phosphor-bronze worm wheel meshing with a nickel-steel hardened, ground and polished worm, with thrust taken by a ball bearing. This drive runs in oil in an inclosed case. Removable phosphor-bronze bearings are used throughout. A sheet-steel housing inclosing motor and starter is furnished. The machine takes 22x44-in. of space. The shipping weight is 750 lb., with an a.c. motor and 950 lb. with d.c. motor. One laborer can operate it.

Electric Haulage to Be Used in Open Pit

The first haulage electrification of an open-pit iron mine in America will be made with the installation of three 60-ton electric locomotives recently purchased by the M. A. Hanna Co. of Duluth, Minn., from the General Electric Co. These units will be of the double-truck type and will be operated from a 250-volt third-rail supply. Each locomotive will be equipped with an auxiliary cable reel to be used when temporary track extensions are made beyond the third rail.

The same company also received orders from this concern for substation equipment to be used in furnishing power for this installation. This will include two 300-kilowatt rotary converters with transformers and switchboards. When this apparatus, together with the locomotives, is installed, the mine will be completely electrified, as there is now in operation an electric shovel equipped with electric motors and control.

Advantages of Dust-collecting Equipment

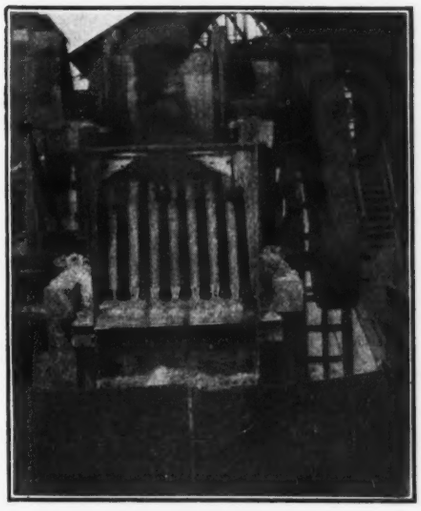
That dust control in mills and crushing plants pays because it increases the efficiency of men and machines and reduces labor turnover was pointed out by George E. Lynch in an article in the *Journal-Press* of Jan. 26. It is also true that the dust so saved contains values that are worth recovering. The new bulletin S-90, issued by the W. W. Sly Manufacturing Co., of Cleveland, Ohio, will interest those who wish to investigate the subject further. Under the title "Dust—a Loss or a Gain" it describes in detail the Sly dust arrester and shows photographs of numerous installations. The equipment made by the company is built to standard specifications. The design as well as the various types and sizes of standard machines permit certain variations in dimensions, style of drive, application and arrangement to conform to the needs of the individual purchaser and the conditions at his plant.

A Self-cleaning Grizzly

By I. J. Simcox and H. L. Humes

To expedite the separation of the fines from the crusher sizes on the mill run of mine ore the Nelson grizzly has been developed at the Copper Queen smelter, Douglas, Ariz. The ore fed to the grizzly is a siliceous sulphide ore, high in talcy material containing 10 to 12 per cent moisture, about 75 per cent of the whole feed being under 2-in. mesh. Owing to this talcy nature of the ore, and to the high percentage of moisture, screening with ordinary types of grizzlies is practically impossible, as the fines "ball up" and thus prevent efficient screening. Furthermore, it is impossible to operate a primary crusher with this class of ore without first removing the wet talcy fines. If the whole feed is delivered to the crusher, the capacity is reduced appreciably. During the season of heavy rains, it was almost impossible to operate the crusher plant due to the increase in moisture.

The grizzly consists of seven parallel manganese-steel bars, rounded on top and tapered to a point underneath. They are concave, with a 12-in. radius at the conveyor end, and convex, with a 24-in. radius, at the crusher end. These bars are supported by a cross bar at both the conveyor and crusher ends, the whole being fixed rigidly to the grizzly frame. On each side of the grizzly there is a manganese-steel side bar, 8 in. high, of the same shape as the grizzly bars, to protect the iron sides of the grizzly from undue wear.



Self-cleaning grizzly delivering to crusher and receiving from conveyor

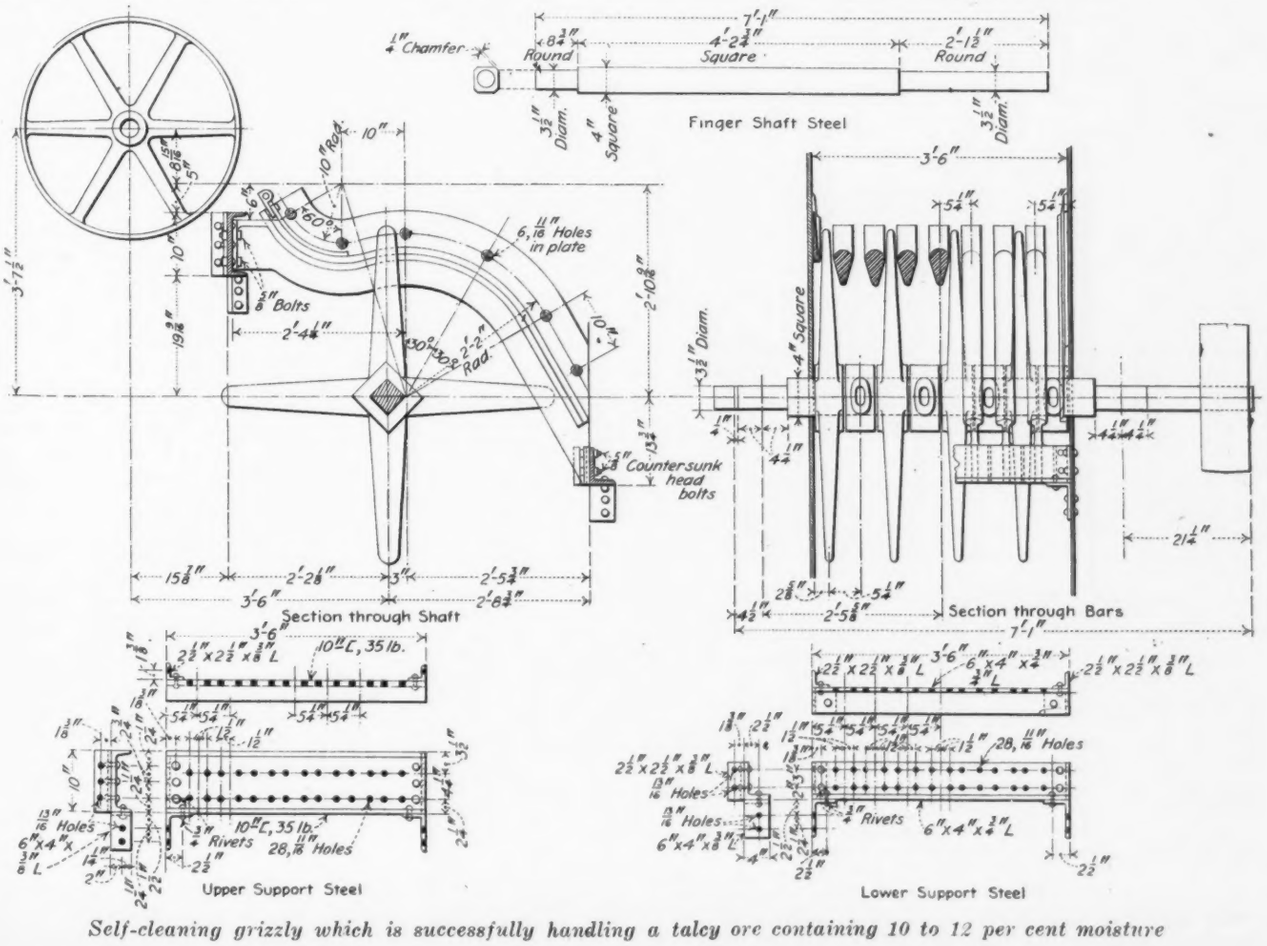
To break up lumps of wet fines, and to propel the oversize along and over the grizzly, eight steel arms revolve about a shaft 4 in. square. They are set alternately at 90 deg. to each other, and project 3 in. above the grizzly bars. To distribute the feed evenly over the grizzly, and to prevent excessive wear on the central bars, a spreader plate is located at the head of the grizzly at about 45 deg. to the horizontal, hinged at the top. As the feed falls on this plate, the revolving arms kick the plate enough to give even distribution to the ore.

The whole installation occupies a space of only 4½ ft. square, at the end of the conveyor belt. The grizzly has operated at a capacity of 196 tons per hour, (the maximum capacity of the crusher). For screening wet talcy ore, it has proven very efficient. Since its installation in August, 1922, it has given satisfactory results, little trouble being experienced.

Prior to this development, and owing to the impossibility of efficiently screening wet talcy ore with other types of grizzlies, about one-third of the total ore had to be air dried, and reclaimed with a steam shovel. This was quite a costly operation, which has been entirely eliminated, as a result of the development of this type of grizzly.

New Instrument Circular Out

The Westinghouse Electric & Manufacturing Co. has recently issued a 24-page, two-color, well-illustrated booklet, Circular 1,664, entitled "Indicating Instruments for Direct and Alternating Currents." The introductory chapter includes a brief and interesting résumé of the development of electricity, with special reference to the development of alternating current and the earlier alternating-current instruments. In the second chapter is related the story of the research that resulted in these new instruments, and there also are discussed the principles of operation and construction of the instruments as now manufactured. The remainder of the book is devoted to the instruments themselves.



Self-cleaning grizzly which is successfully handling a talcy ore containing 10 to 12 per cent moisture

THE MARKET REPORT

Daily Prices of Metals

Feb.	Copper, N. Y. net refinery*	Tin		Lead		Zinc
	Electrolytic	99 Per Cent	Straits	N. Y.	St. L.	St. L.
7	12.25@12.375	52.50	53.00	8.25	8.25@8.40	6⅝@6.675
8	12.25@12.375	52.25	52.75	8.25	8.25@8.50	6.675@6.70
9	12.35@12.50	51.75	52.25	8.275	8.25@8.50	6.70
11	12.45	51.50	52.00	8.275	8.25@8.50	6.70@6.75
12	.....	.....	.....	.....	.....	.....
13	12.50	53.50	54.00	8.275	8.25@8.50	6.725@6.75
Av.	12.400	52.30	52.80	8.265	8.365	6.700

*These prices correspond to the following quotations for copper delivered: Feb. 7th and 8th, 12.50@12.625c.; 9th, 12.60@12.75c.; 11th, 12.70c.; 14th, 12.75c.

The above quotations are our appraisal of the average of the major markets based generally on sales as made and reported by producers and agencies, and represent to the best of our judgment the prevailing values of the metals for deliveries constituting the major markets, reduced to the basis of New York cash, except where St. Louis is the normal basing point, or as otherwise noted. All prices are in cents per pound. Copper is commonly sold "delivered," which means that the seller pays the freight from the refinery to the buyer's destination.

Quotations for copper are for ordinary forms of wire bars, ingot bars and cakes. For ingots an extra of 0.05c. per lb. is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

The quotations are arrived at by a committee consisting of the market editors of *Engineering and Mining Journal-Press* and a special representative of the Bureau of Mines and the Bureau of Foreign and Domestic Commerce.

London

Feb.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
7	61⅛	62	66	264½	261¾	33¼	32¼	35⅝	34½
8	61⅝	62½	66¼	265⅝	262¾	33⅝	32⅜	35⅝	34¾
11	62⅜	63¼	67	266	262⅞	34	32¾	36⅛	35
12	62⅝	63½	67	268½	266	34	32¾	36¼	35⅛
13	62⅝	63½	67¼	275½	271¾	34	32¾	36⅜	35¼

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Feb.	Sterling Exchange "Checks"	Silver		Gold London	Feb.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
7	4.32¼	64⅛	33⅜	95s 4d	11	4.29½	64⅞	33 15/16	95s 10d
8	4.30½	64⅛	33⅜	95s 6d	12	.....	...	33⅞	96s 1d
9	4.30½	64⅝	33 11/16	.....	13	4.30	65¼	34 3/16	95s 8d

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-quarter of a cent premium.

Metal Markets

New York, Feb. 13, 1924

Copper has at last joined its sister non-ferrous metals in an advancing market, having turned the corner about a week ago. The scarcity in lead continues, with higher prices, and the demand for zinc has been unusually strong. The tin market may be likened to that of lead in that there is not a sufficient quantity of metal available for prompt delivery to meet demands.

Copper

At least two producers were selling copper a week ago at 12½c. for points where normal delivery charges obtained, but the several thousand tons of metal available at this price was all taken up by Friday night. Some producers held throughout the week at 12¾c. but only succeeded in obtaining this price in the last few days, 12⅝c. being the price at which most of the business was done on Friday and Saturday. Monday most of the sales were at 12¾c. and today some copper has been sold as high as 12⅞c. to points where delivery charges are high; in no case have sellers been willing to accept less than 12¾c. today, even though the consumer is situated near the refinery. The volume of sales for the week has been very satisfactory although the total is not extremely large. The foreign demand has also improved, which no doubt played a part in making producers more optimistic as to prices.

The data heretofore compiled by the Copper Export Association will hereafter be undertaken by the American Bureau of Metal Statistics, the change having been effective with the publication of the statistics for January. These show, as reported by the *Wall Street Journal*, foreign and domestic shipments of 215,000,000 lb. compared with 191,000,000 in December and 224,000,000 in November, which was the previous high month. Domestic shipments were 145,000,000 lb. compared with 105,000,000 in December and 128,000,000 in November. Refinery output is given as 224,000,000 lb. in January compared with 239,000,000 lb. in December and 229,000,000 lb. in November. The stocks of refined copper, therefore, increased approximately 9,000,000 lb. in January, being about 320,000,000 lb. on Feb. 1; this increase, however, was at the expense of blister copper stocks, actual smelter production being about equal to shipments.

Lead

On Thursday, Feb. 7, the official contract price of the American Smelting & Refining Co. was advanced from 8.15 to 8.25c. per lb., New York.

The shortage of lead for domestic consumption continues. Consumers are pressing producers for prompt shipment metal but without much success. They are even appealing to each other, in some cases, to help them out with small lots. A feature of the week's business has been the prevalence of forward sales, a few of them extending into May, for which a price of 8.55c. St. Louis was obtained. For shipment in March, 8⅜c. St. Louis was obtained earlier in the week. Practically all the sales made during the week, outside of contracts, were in St. Louis. The New York market was dominated by the heavy contract sales which, as usual, far outweighed the sales based upon individual negotiations. Without doubt immediate shipment lead in New York is worth a stiff premium but none seems to be available. One producer feels that some 500 to 1,000 tons of spot lead are needed to remove the premium in the spot market. In the Middle West, a sale of spot lead was made Monday on a basis of 8⅜c. Last Friday and Saturday, April shipment sold for 8¼ and 8.325c. respectively.

An encouraging report comes from one large western producer to the effect that his production will be larger in March and April. This would aid in easing the acuteness of the situation. In fact it is surprising that production generally has not been stimulated more by the high price of lead, particularly in Utah where production dropped after the expiration of Pittman Act silver purchases.

Zinc

The past week in the zinc market has seen the largest volume of business that has been booked for some time. Most of the metal has been sold to galvanizers, but brass makers have also entered the market more than they have recently. Prices have advanced both here and in London as a reflection of the improved business despite the fact that statistics released by the American Zinc Institute at the week-end showed a further increase in stocks. On Jan. 1, the stock was 36,578 tons, and during January 49,709 tons was produced. Shipments amounted to 45,590, leaving a stock on hand, Jan. 31, of 40,697 tons. There was shipped for export 3,798 tons. On Jan. 31, 78,768 retorts were operating. The decreased smelting capacity over that of the previous month amounts to about 3,500 tons but did not become effective until near the end of the month. Since then other blocks have been shut down so that the total decrease in capacity is probably about 5,000 tons, though with increasing prices some furnaces may be put back into operation. High-grade zinc continues at 8@8½c. delivered in the East.

Tin

The scramble for tin continues and prices have advanced further. The amount now being produced does not seem to be equal to the demand, and the shortage is hardly offset by the stocks that are being released in the Far East. However, it is probable that the recent sharply advancing prices have stimulated a demand that is somewhat greater than actual consuming requirements.

Tin for forward delivery has sold at from one-half to one cent below the prices named for spot.

Arrivals so far in February amount to 3,625 long tons.

Foreign Exchange

On Monday, Feb. 11, cable quotations on francs were 4.5775c.; lire 4.3825c.; and Canadian dollars 2$\frac{3}{32}$ per cent discount.

Silver

Since the resumption of business in China after their New Year holidays, the demand has improved considerably and prices have advanced accordingly. This is a change from recent conditions where support for the market came chiefly from the Indian bazaars.

Mexican Dollars—Feb. 7th, 48⅞; 8th, 48⅞; 9th, 49⅛; 11th, 49½; 13th, 49¾.

Other Metals

Quotations cover large wholesale lots unless otherwise specified.

Aluminum—99 per cent grade 28c. per lb.; 98 per cent, 27c. London, £115 per long ton.

Antimony—Per lb.:

Chinese and Japanese brands, 10.50c.

W. C. C. brand, 12c.

Cookson's "C" grade, 13@13½c.

Chinese needle, lump, nominal, 8@9c.

Standard powdered needle, 200 mesh, 8½@9½c.

White oxide, Chinese, 99 per cent Sb_2O_3, 9c.

Bismuth—$2.35@$2.45 per lb. London, 10s.

Cadmium—70@75c. per lb. London, 2s. 6d.

Cobalt—$2.50@$3 per lb. for spot.

Iridium—$275@$300 per oz.

Nickel—26@30c. per lb. for 99 per cent virgin metal. London, £130 long ton.

Osmiridium — Crude, $58.50 per oz.

Palladium—$83 per oz. Crude, $60 per oz.

Platinum — Refined, $125 per oz. Crude platinum, $116@$117 per oz.

Quicksilver—$58@$60 per 75-lb. flask. Quiet. San Francisco wires $60.00. London, £9 15s.

The prices of **Magnesium, Molybdenum, Monel Metal, Osmium, Radium, Rhodium, Selenium, Tellurium, Thallium,** and **Tungsten** are unchanged from prices given Feb. 9.

Metallic Ores

Chrome—$19.50@$24, depending upon grade and source. Nominal.

Manganese—42@46c. per long ton unit, seaport, plus duty.

Molybdenum—80c. per lb. of MoS_2 for 85 per cent concentrates. Nominal.

Tungsten Ore—Per unit, N. Y:
High-grade wolframite, $8.50.
High-grade scheelite, $9.50@$10.
Ordinary grades, $8.35@$8.50.

Iron Ore, Magnetite, Tantalum, Vanadium, and **Zircon Ore** are unchanged from Feb. 9 quotations.

Zinc and Lead Ore Markets

Joplin, Mo., Feb. 9—Zinc blende, per ton, high, $46.90; basis 60 per cent zinc, premium, $45@$46; Prime Western, $44; fines and slimes, $43@$41; average settling price, all zinc ores, $44.83.

Lead, high, $118.10; basis 80 per cent lead, $118.50; average settling price, all lead ores, $113.85 per ton.

Shipments for the week: Blende, 11,776; lead, 1,294 tons. Value, all ores the week, $675,170.

Lead advanced another $1 per ton on offerings, with the production limited to considerably less than the demand. One company withdrawing from the market this week probably prevented a larger advance in the price.

Platteville, Wis., Feb. 2—Blende, basis 60 per cent zinc, $47.50 per ton. Lead, basis 80 per cent lead, $118 per ton. Shipment for the week: Blende, 430 tons; lead, 40 tons. Shipments for the year: Blende, 3,343; lead, 80 tons. Shipments for the week to separating plants: 841 tons blende.

Platteville, Wis., Feb. 9—Blende, basis 60 per cent zinc, $47.50 per ton. Lead, basis 80 per cent lead, $118 per ton. Shipments for the week: Blende, 430 tons; lead, none. Shipments for the year; Blende, 3,343; lead, 80 tons. Shipments for the week to separating plants: 841 tons blende.

Non-Metallic Minerals

Asbestos:
Crude No. 1—$300@$400.
Crude No. 2—$175@$225.
Spinning fibers—$90@$125.
Magnesia and compressed sheet fibers—$60@$90.
Shingle stock—$50@$70.
Paper stock—$32.50@$40.
Cement stock—$20@$25.
Floats—$7@$9.
All per short ton, f.o.b. mines, Quebec, tax and bags included.

Bauxite, Barytes, Beryl, Borax, Chalk, China Clay, Diatomaceous Earth, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Graphite, Gypsum, Ilmenite, Limestone, Magnesite, Manjak, Mica, Monazite, Phosphate, Pumice, Pyrites, Rutile, Silica, Sulphur, Talc are unchanged from Feb. 9 prices.

Mineral Products

Arsenious Oxide (white arsenic)—12½c. per lb. Little demand.

Copper Sulphate—4.65@4.75c. per lb.

Potassium Sulphate, Sodium Sulphate and **Sodium Nitrate** are unchanged from the Feb. 9 prices.

Ferro-Alloys

Ferrochrome, Ferromanganese, Ferromolybdenum, Ferrosilicon, Ferrotitanium, Ferrotungsten, Ferro-uranium and **Ferrovanadium** are unchanged from the prices given in the Feb. 9 issue.

Metal Products

Copper—Sheets, 20.50c. base; wire, 15⅝c.

Lead Sheets—Cut, 10.50c.; full, 10.25c. per lb.

Nickel Silver—18 per cent Grade A sheets, 26.75c.

Yellow Metal — Dimension sheets, 18.25c.; rods, 15.25c.

Zinc Sheets—Base price, $9.75 per 100 lb., f.o.b. plant.

Refractories

Bauxite Brick, Chrome Brick, Firebrick, Magnesite Brick, Magnesite Cement, Silica Brick and **Zirkite** are unchanged from the Feb. 9 prices.

The Iron Trade

Pittsburgh, Feb. 12, 1924.

Production of steel ingots in January was at 133,331 tons daily or 41,500,000 tons annual rate, representing a 17-per cent increase over December and a rate 14 per cent under the peak rate of last April. Month by month after April, and through December, production declined, and the January rate represents a rebound to the rate of September.

Steel prices are very steady. The maintenance of prices has had much to do with willingness of buyers to replenish stocks. At the same time there is little forward buying, as mills can be depended upon to furnish deliveries as desired, since mills are working smoothly and still have idle capacity.

Pig Iron—Asking prices are: Bessemer, $24; basic, $23; foundry, $24; f.o.b. Valley furnaces, freight to Pittsburgh being $1.76.

Connellsville Coke—Spot furnace, $4 @$4.15 and firm. Furnaces recently inquiring for second quarter have been indisposed to pay advanced prices asked, generally $4.40 or $4.50, and some of the negotiations have been dropped. Recent contracts, for balance of quarter, were at $4.25. Spot foundry, $5@$5.50.

Freight Rates on Metals, Ores, and Concentrates

Carload Lots

Copper Bullion and Refined Copper

From	To	Rate per Ton of 2,000 Lb. All Rail	Via Gulf
El Paso, Tex.	Baltimore, Md.	$11.40	$10.00
Garfield, Utah	Perth Amboy	12.50	.....
Garfield, Utah	San Francisco	5.85	.....
Hayden, Ariz.	Perth Amboy	14.50	12.50
Miami, Ariz.	Perth Amboy	14.50	12.50
Anaconda, Mont.	Perth Amboy	12.50	.....
Butte, Mont.	Perth Amboy	12.50	.....
Humboldt, Ariz.	Chrome, N. J.	14.50	12.50
Douglas, Ariz.	Perth Amboy	14.50	12.50
Globe, Ariz.	Perth Amboy	14.50	12.50
Clifton, Ariz.	Perth Amboy	14.50	12.50
Clarkdale, Ariz.	Chrome, N. J.	14.50	12.50
Copperhill, Tenn.	Laurel Hill, N. Y.	$10.80	.....
Tooele, Utah	Chrome, N. J.	12.50	.....
McGill, Nev.	Baltimore, Md.	15.90	.....
Houghton, Mich.	New York	(a) 11.40	.....
Hancock, Mich.	New York	(a) 11.40	.....
Hubbell, Mich.	New York	(a) 11.40	.....
Dollar Bay, Mich.	New York	(a) 11.40	.....
Tacoma, Wash.	New York via Canal	Conference rate	$6.00
Anaconda, Mont.	Tacoma, Wash.	7.09	.....
Ajo, Ariz.	New York	14.50	$12.50

(a) Applies Dec. 1 to April 1.

Marine Freight Rates

New York to
- Hamburg: $4.00 per gross ton copper and lead
- Liverpool: $4.00 per gross ton copper and lead
- Antwerp: $3.50 per gross ton copper and lead
- Havre: $3.75 per gross ton lead; $4.25 per gross ton copper

Gulf ports to
- Hamburg: $4.00 per gross ton copper and lead
- Liverpool: $4.00 per gross ton copper and lead
- Antwerp: $3.50 per gross ton copper and lead
- Havre: $4.25 per gross ton copper

Pacific coast ports to
- Hongkong: $6.00 per short ton
- Kobe: $6.00 per short ton

Tampico to
- Liverpool Bremen, Hamburg, Rotterdam
- Havre: $4.50 per metric ton
- Dunkirk: $6 per metric ton

Lead Bullion; (Pig Lead Where Shown)

From	Rates per Ton of 2,000 Lb. To New York		To St. Louis
East St. Louis, Ill.	$7.00		.....
Pueblo, Colo.	14.15		$9.65
Leadville, Colo.	16.50		11.40
East Helena, Mont	16.50		11.40
El Paso, Tex.	*10.00	Via Gulf	
	(c) 14.00	All Rail	(b) 7.76½
Omaha, Neb.	9.60		3.65
Murray, Utah	16.50		11.40
Midvale, Utah	16.50		11.40
Tooele, Utah	16.50		11.40
East Chicago, Ill.	6.40		(a) 2.00
Kellogg, Idaho	16.50		11.40
Carnegie, Pa.	3.80		(a) 5.00
Selby, Calif.	(a) 6.00		.....
Herculaneum, Mo.	(a) 8.80		(a) 1.80
Federal, Ill.	7.00		(a) 1.80
Collinsville, Ill.	7.00		(a) .75½
Granby, Mo.	(a) 10.50		(a) 3.50
Joplin, Mo.	(a) 10.50		(a) 3.50

(a) Pig lead only.
(b) Pig lead only when originating in Mexico.
(c) Shipments of bullion originating in Mexico, $2 per ton less.
(d) Conference rate, via canal.

Slab Zinc

From	Rates per Net Ton to E.St. Louis	New York
Donora, Pa.	(a) $4.60	$3.80
Langeloth, Pa.	(a) 4.60	3.80
Palmerton, Pa.	7.10	3.00
Hillsboro, Ill.	1.40	7.00
Danville, Ill.	2.00	6.40
La Salle, Ill.	2.00	6.70
Springfield, Ill.	3.00	7.00
Cleveland, Ohio	5.80	5.00
Moundsville, W. Va.	4.40	3.80
Van Buren, Ark.	3.80	10.80
Fort Smith, Ark.	3.80	10.80
Bartlesville, Okla.	3.50	10.50
Blackwell, Okla.	3.80	10.80
Henryetta, Okla.	3.80	10.80
Sand Springs, Okla.	3.80	10.80
Cherryvale, Kan.	3.50	10.50
Black Eagle, Mont.	9.40	12.50
Park City, Utah	9.00	12.50

(a) To St. Louis, Mo.

Zinc Ores and Concentrates

To	From	Rate per Net Ton
Bartlesville, Okla.	Altoona, Kan.	$2.10
	Pittsburg, Kan.	1.09
	Galena, Kan.	1.30
	Joplin, Mo.	1.40
	Iola, Kan.	1.09
	Baxter, Kan.	1.40
	Miami, Okla.	1.40
	Quapaw, Okla.	1.40
	Kansas City, Mo.	1.60
Sand Springs, Okla.	Miami, Okla.	2.20
	Quapaw, Okla.	2.20
	Galena, Kan.	1.50
	Joplin, Mo.	1.50
	Iola, Kan.	2.40
Dewar, Okla.	Cave Springs, Mo.	2.00
	Cent City Spur, Mo.	2.00
Kusa, Okla.	Chitwood, Mo.	2.00
Henryetta, Okla.	Galena, Kan.	1.50
	Iola, Kan.	2.40
	La Harpe, Kan.	2.40
La Harpe, Kan.	Mound City, Kan.	.50
	Oswego, Kan.	.50
	Parsons, Kan.	.50
Coffeyville, Kan.	Galena, Kan.	1.10
	Joplin, Mo.	1.22
Bartlesville, Okla. (a)	Baxter, Kan.	1.80
	Miami, Okla.	1.80
	Quapaw, Okla.	1.80

(a) Lead ore and concentrates.

Rates on Ores and Concentrates

From	To	Value of Product $5	$10	$15	$20	$25	$30	$35	$40	$50	$60	$70	$75	$80	$90	$100
		Rate														
Butte, Mont.	Anaconda, Mont.	.17	.17	.17	.17	.17	.17	.17	.17	.17	.17	.17	17	.17	.17	.17
Butte, Mont.	Black Eagle, Mont. (a)	....	....	....	....	....	....	....	1.01	....	....	....	....	....	....	....
Great Falls, Mont.	East Helena, Mont.	....	....	1.57	....	1.76	....	1.98	....	2.43	....	....	....	....	....	2.55
Butte, Mont.	East Helena, Mont.	....	....	1.17	....	1.46	....	1.69	....	2.03	....	....	....	....	....	2.14
Paxton, Calif.	Salt Lake Smelters, Utah	....	....	....	....	....	....	....	....	6.30	7.00	7.70	....	8.35	8.60	8.85
Johannesburg, Calif.	Selby, Calif.	....	....	....	2.90	....	3.50	....	4.10	4.70	5.30	5.90	....	6.50	6.80	7.10
Johannesburg, Calif.	Humboldt, Ariz.	....	....	....	3.40	....	4.10	....	4.80	5.50	6.20	6.90	....	7.60	8.00	8.30
Pioche, Nev.	Humboldt, Ariz.	....	4.50(c)	7.74	....	8.55	....	9.36	....	9 99	....	....	1 .5	....	....	12.42
Creede, Colo.	Durango, Colo.	....	....	3.25	3.50	3.75	4.00	....	4.25	4.75	5.25	5.75	.(5	....	....	7.10
Ouray, Colo.	Durango, Colo.	....	....	4.30	4.80	....	5.05	....	....	5.90	....	6.30	....	....	....	7.70
Kokomo, Colo.	Durango, Colo.	....	6.00	....	....	6.50	7.20	....	....	....	....	....	....	....	....	....
Telluride, Colo.	Durango, Colo.	....	....	....	....	....	4.30	....	5.00	5 90	6.30	6.3	....	....	....	7.70
Silverton, Colo.	Durango, Colo.	....	....	1.40	1 40	....	....	2.20	....	....	2.30	2.	....	2.80	....	2.80
Tyrone, N. M.	Douglas, Ariz.	....	....	1.60	1 90	....	2.20	....	2.50	2 80	....	..	3 40	....	....	3.80
Tyrone, N. M.	El Paso, Tex.	....	....	1.60	1 90	....	2.20	....	2.50	2 80	....	..	3 40	....	....	3.80
Lordsburg, N. M.	Douglas, Ariz.	....	1.00	1.30	1 60	....	1.90	....	2.20	2 50	....	....	z.80	....	....	3.40
Lordsburg, N. M.	El Paso, Tex.	....	1.00	1.30	1.60	....	1.90	....	2.20	z.50	....	....	2.80	....	....	3.40
Tombstone, Ariz.	Douglas, Ariz.	....	....	.60	....	.90	....	....	....	.30	....	....	.60	....	....	1.90
Tombstone, Ariz.	El Paso, Tex.	....	....	1.90	....	2.50	....	....	....	3.80	....	....	.40	....	....	4.40
Silver City, N. M.	Douglas, Ariz.	....	....	2.48	....	3.15	....	....	....	3.83	....	....	....	....	....	5.29
Ray Junction, Ariz.	Hayden, Ariz.	....	.10	....	.40	....	.50	....	.80	.90	....	....	.00	....	....	1.10
Sandon, B. C. / Alamo Concentrator, B. C.	Tadanac, B. C.	1.50	1.60	1.70	1.90	2.00	2.50	....	2.60	2 90	3.40	3.50	....	3.70	3.80	3.90
Rossland, B. C.	Tadanac, B. C.	.90	.90	1.00	1.00	1.10	1.50	....	1.60	1.60	1.60	1.70	....	1.70	1.70	1.70
Rossland, B. C.	Tadanac, B. C(d).	.30	.30	.30	.30	.50	.70	....	.80	.80	....	....	....	....	....	....
Republic, Wash.	Tadanac, B. C.	....	2.02	2.50	2.66	2.86	3.84	....	3.84	3.84	4.69	4.89	....	5.19	5.39	5.59

(a) Minimum tonnage of 200 tons per day. (b) In open cars, minimum 80,000 lb. (c) Siliceous ore tailing.
(d) Applicable on ore, only when shipped in trainload lots of not less than 10 cars and exclusive of switching charges at Rossland.

From	To	Value of Ores and Concentrates $10	$15	$20	$25	$30	$35	$40	$50	$60	$70	$75	$80	$90	$100
		Rate													
Burke, Idaho	Bradley, Idaho	....	....	....	....	....	....	....	....	.68	.....	.....	....	....	1.02
Burke and Wallace, Idaho	East Helena, Mont.	....	....	....	....	3.00	....	3.25	3.50	3.75	4.00	.....	4.25	4.50	4.75
Sagel, Idaho	East Helena, Mont.	....	....	....	3.38	....	3.83	....	4.16	....	....	.....	....	....	4.84
Arizona Tunnel, Idaho	Bradley, Idaho	....	....	....	....	....	....	....	....	.35	....	.....	....	....	.50
Bayview, Idaho	Bradley, Idaho	....	....	....	....	....	....	....	3.75	....	....	4.37½	....	....	5.12½
Park City, Utah	Salt Lake Smelters	1.00	1.10	1.25	....	1.50	....	1.75	....	2.00	....	.....	2.25	....	2.50
Eureka, Utah	Salt Lake Smelters	1.00	....	1.25	....	1.50	....	1.75	2.00	2.25	2.50	.....	2.75	3.00	3.25
Tintic, Utah	Salt Lake Smelters	1.00	....	1.25	....	1.50	....	1.75	2.00	2.25	2.50	.....	2.75	3.00	3.25
St. Johns, Utah	Salt Lake Smelters	1.00	....	1.25	....	1.50	....	1.75	2.00	2.25	2.50	.....	2.75	3.00	3.25
Ophir, Utah	Salt Lake Smelters	1.00	....	1.25	....	1.50	....	1.75	2.00	2.25	2.50	.....	2.75	3.00	3.25
Bingham, Utah	Garfield, Utah	....	.40	....	.75	....	....	....	.95	....	....	1.10	....	....	1.25
Cherry Creek, Nev.	Garfield, Utah (c)	....	....	4.60	....	5.10	....	5.60	6.10	6.60	7.10	.....	7.60	8.10	8.60
Cherry Creek, Nev.	Garfield, Utah (b)	....	....	3.20	....	3.90	....	4.60	5.30	6.00	6.70	.....	7.40	....	....
Goldfield, Nev.	Salt Lake Smelters	....	....	5.10	....	5.80	....	6.50	7.20	7.90	8.60	.....	9.30	10.00	10.70
Battle Mountain, Nev. (a)	Salt Lake Smelters	....	4.15	3.20	....	3.80	....	4.40	5.00	5.60	6.20	.....	6.80	7.40	8.00
Palisade, Nev. (a)	Salt Lake Smelters	....	....	3.20	....	3.80	....	4.40	5.00	5.60	6.20	.....	6.80	7.40	8.00
Mina, Nev. (a)	Salt Lake Smelters	....	....	3.60	....	4.30	....	5.00	5.70	6.40	7.10	.....	7.80	8.50	9.20
Lovelock, Nev. (a)	Salt Lake Smelters	....	....	3.20	....	3.90	....	4.60	5.30	6.00	6.70	.....	7.40	8.10	8.80
Golconda, Nev. (a)	Salt Lake Smelters	....	....	3.20	....	3.90	....	4.60	5.30	6.00	6.70	.....	7.40	8.10	8 80
Hazen, Nev. (a)	Salt Lake Smelters	....	....	3.20	....	3.90	....	4.60	5.30	6.00	6.70	.....	7.40	8.10	8.80
Tonopah, Nev.	Salt Lake Smelters	....	4.15	5.10	....	5.80	....	6.50	7.20	7.90	8.60	.....	9.30	10.00	10.70
Rogerson, Idaho	Salt Lake Smelters	3.00	....	3.50	....	4.00	....	4.50	5.00	5.50	6.00	.....	6.50	7.00	7.50
Georgetown, Colo.	Leadville, Colo.	....	....	3.50	....	3.75	....	4.00	5.00	5.00	5.80	.....	5.80	5.80	5.80
Shirley, Colo.	Leadville, Colo.	....	....	2.25	....	2.25	....	2.25	2.25	4.30	4.30	.....	4.30	4.30	4.30

(a) Minimum weight, marked capacity of car used, but not less than 80,000 lb. (b) Minimum weight, 80,000 lb. (c) Minimum weight, 40,000 lb.
* Indicates a change of tariff since last report.

Imports and Exports of Metals in December, 1922 and 1923

Imports of Ores and Metals

In Pounds Unless Otherwise Stated

	December, 1922	December, 1923
Antimony		
Ore		331,873
Metal, matte, and regulus	528,745	1,594,975
Copper		
Ore	3,430,469	9,480,674
Concentrates	6,519,375	4,403,251
Regulus, coarse metal and cement copper	40,466	
Total	9,990,310	13,883,925
Imported from:		
Spain	495,360	3,152,765
Canada	498,410	32,433
Mexico	3,657,818	1,721,619
Cuba	2,405,861	3,332,723
Chile	2,441,308	4,486,649
Colombia		45
Peru	462,710	194,947
Venezuela		351,254
Other countries	28,843	611,490
Unrefined black, blister and converter copper in pigs and bars	42,290,296	18,802,829
Imported from:		244,073
Spain	3,403,632	21,304
United Kingdom	6,247,944	1,075,520
Canada	9,941,962	4,430,127
Mexico	13,946,884	569,913
Chile	5,258,565	405,705
Peru	2,364,520	6,364,020
Portuguese Africa	1,126,789	5,692,167
Other countries		
	7,291,828	20,211,821
Refined copper	489,562	289,941
Old and clippings for remanufacture	1,925	
Composition metal, copper chief value	8,157	45,879
Copper manufactures		
Brass	2,889,670	684,772
Old and clippings for remanufacture	46,881	101,585
Manufactures of brass		
Lead	3,607,873	8,968,819
Ore and matte	3,766,833	16,471,058
Bullion or base bullion	1,444,930	67,797
Pigs, bars, other forms and old	13,820	43,770
Manufactures of lead (except type metal)	18,305	12,003
Manganese ore, long tons	60,737	25,010
Pyrites, long tons		
	969	15
Tin	16,639,440	12,576,768
Tin ore, tons		
Tin in bars, blocks and pigs	485,831	2,635,414
Imported from:	11,274,104	8,052,608
United Kingdom	280,639	
British Straits Settlements	2,041,559	340,980
China	2,086,712	992,457
Dutch East Indies	190,400	11,200
Hongkong	280,195	544,109
Australia		
Other countries		508,902
Zinc ore (dutiable)	1,113	1,302
Zinc in blocks and pigs (dutiable)	3,228	5,999
Zinc dust (dutiable)		

Exports of Copper, Lead, and Zinc

In Pounds

	December, 1922	December, 1923
Copper		
Ores, concentrates matte, and regulus (copper content)	51,720,425	77,260,167
Copper and manufacture of (total)	44,499,459	70,170,983
Refined, in ingots and bars		
Exported to	2,319,632	3,498,900
Belgium	10,547,505	23,437,428
France	11,690,117	7,447,471
Germany	4,788,129	6,960,126
Italy	2,623,732	930,275
Netherlands	1,515,252	134,419
Spain	1,009,597	3,746,388
Sweden	8,123,139	13,068,777
United Kingdom	651,943	1,019,655
Canada	448,000	4,346,181
China		3,919,638
Japan	782,413	1,661,725
Other countries	237,809	223,082
Old and scrap	5,481	717
Composition metal, copper chief value	157,619	177,442
Pipes and tubes	254,902	164,743
Plates and sheets		1,320,506
Wire except insulated		
Lead	2,021,367	92,121
Pigs and bars	7,984,381	11,398,066
From domestic ore		
From foreign ore	4,930,324	3,024,759
Exported to:	1,344,521	616,257
France	168,127	896,176
Germany	2,464,940	5,903,702
Netherlands		560,198
United Kingdom		168,007
Other Europe	678,925	224,065
Argentina	44,140	
Brazil	374,771	97,023
Japan		
Other countries		
Zinc	979,934	1,494,200
Dross	4,775,537	2,480,732
Spelter:	3,783,476	1,792,352
From domestic ore	8,559,013	4,273,084
From foreign ore		
Total zinc slab and blocks	1,220,680	1,344,412
Exported to	6,527,289	1,848,423
France	104,333	1,849
United Kingdom	706,711	1,078,400
Canada	900,787	671,030
Other countries	706,506	660,236
In and sheetsstrips	42,258	195,368
Zinc dust		
Other zinc manufactures		

Tonopah Belmont Development Co.

A condensed statement of operations of the Tonopah Belmont Development Co. for the quarter ended Sept. 30, 1923 follows:

Received and receivable for ore	$188,845.21
Mining, milling and administration expenses	161,472.29
Total net income for three months ended Sept. 30, 1923	$27,372.92

Available Resources, Nov. 30, 1923

Due from smelter	$60,050.06
Due from others	138,057.70
Cash in banks	274,981.62
U. S. Treasury Notes	100,000.00
Liberty bonds	50,031.25
	$623,120.63

The net earnings for the quarter ended Sept. 30, 1923, of the Belmont Surf Inlet Mines, Ltd., of which this company owns 80 per cent, were $13,245.72.

The competition of silver purchases at $1 per oz., under the Pittman Act, in June, necessitated the selling of silver bullion at the regular current quotations, which have been between 63 and 64c. per oz. With silver at this price, a higher-grade ore must be treated to make a profit at the Belmont mine. The cost of producing silver at Tonopah increased from 33c. per oz. in 1913 to 60c. in 1923. The high cost of labor, materials and supplies increased the total working cost (including metallurgical losses) to about $15 per ton, which is higher than the average run of mine ore based on silver at 64c. It therefore became imperative to sort the ore produced to a higher grade, thereby reducing the tonnage to from 75 to 100 tons per day. With no assured custom ore in sight it became uneconomical to operate the Belmont mill (which has a daily capacity of 500 tons) upon such a small tonnage, and the mill was closed down on Aug. 1st. Satisfactory rates having been obtained, the management decided to ship ore to the mill of the Tonopah Mining Co. at Millers, which is more readily adaptable to handle a small tonnage. Meantime, the services of H. P. Henderson, a geologist and mining engineer of wide reputation, thoroughly familiar with the Tonopah district, were obtained to make a careful study of the underground conditions at the Belmont mine. It is believed that more recent exposure and classification of the rocks warrant this examination, with the view of determining the advisability of further development at depth and in unexplored blocks of ground. The management initiated a sweeping reduction in expenses to meet the changed conditions, involving a reduction in salaries from the president down. The position of general manager made vacant Nov. 1 by the resignation of F. Bradshaw will not be filled. On Dec. 18 a new vein was struck on the 1,000 level of the Belmont mine in hitherto unprospected ground. The vein where struck is 5 ft. in width and assays $20.

At the Belmont Surf Inlet mine the same changed economic conditions have prevailed since the war, and profits have been consequently lower.

The option upon the Eagle Shawmut property, in California, has been given up, and the property will revert to the owners on Jan. 16, 1924. Had economic conditions remained the same as when the option was taken, the property could have been operated at a profit instead of a loss.

Productive mining has been discontinued at the Belmont Wagner property, in Colorado, and work confined to driving on the Alta vein without encountering commercial values, although the objective underneath the profitable oreshoots in the upper workings has not yet been reached.

MINING STOCKS

Week Ended February 9, 1924

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Alaska-Br. Col.	N. Y. Curb	*40	*40	*40		
Anaconda	New York	38½	37⅞	38⅛	De.15, Ja.21, Q	0.75
Aracadian Consol.	Boston	1⅝	1½	1½		
Ariz. Com'l.	Boston	9	8½	9	Ja.15, Ja.31	0.50
Calaveras	N. Y. Curb			1½		
Calumet & Arizona	Boston	46	45	45½	De.7, De.24, Q	0.50
Cal. & Hecla (New)	Boston	17⅛	16⅞	17⅛	De. 1, De. 17	0.50
Canario Copper	N. Y. Curb	2 3/16	2	2 3/16		
Cerro de Pasco	New York	47⅛	46⅛	46⅜	Ja. 17, Feb. 1	1.00
Chile Copper	New York	27⅛	27⅛	27⅛	Mh.1 Mh.20, Q	0.62½
Chino	New York	18⅛	17⅞	17⅞	Sept. '20, Q	0.37
Con. Coppermines	N. Y. Curb	2	1⅞	2		
Copper Range	Boston	25	23	23⅞	May '23, Q	1.00
Crystal Copper	Boston Curb	*79	*79	*79		
Davis-Daly	Boston	4⅛	3⅞	4	Mar. '20, Q	0.25
East Butte	Boston	4⅞	4⅛	4⅛	Dec. '19, A	0.50
First National	Boston Curb	*30	*25	*30	Feb. '19, SA	0.15
Franklin	Boston	*85	*80	*80		
Gadsden Copper	Boston Curb			*50		
Granby Consol.	New York	14⅛	14	14	May '19, Q	1.25
Greene-Cananea	New York	15⅛	15	15	Nov. '20, Q	0.50
Hancock	Boston			2		
Howe Sound	N. Y. Curb	3	2⅞	3	Ja.2, Ja.15	0.05
Inspiration Consol.	New York	26⅛	26	26⅛	De.20, Ja.7, Q	0.50
Iron Cap	Boston Curb	3	3	3	May 23, K	0.15
Isle Royale	Boston	17⅞	17½	17⅝	Se. 1, Se. 15,	0.50
Jerome Verde Dev.	N. Y. Curb	1½	1⅜	1½		
Kennecott	New York	37⅛	35⅝	36½	De.7, Ja. 2, Q	0.75
Keweenaw	Boston	*75	*50	*50		
Lake Copper	Boston	1⅞	1⅛	1⅛		
Magma Copper	New York	33¼	32½	32½	Jan. '19, Q	0.50
Mason Valley	N. Y. Curb			1⅛		
Mass Consolidated	Boston	*75	*50	*50	Nov. '17, Q	1.00
Miami Copper	New York	23⅜	22⅞	22⅞	Fe. 1, Fe. 13, Q	0.50
Michigan	Boston			*50		
Mohawk	Boston	33	31	32	Se. 22, Oc. 13,	1.00
Mother Lode Coa.	New York	8⅝	8⅜	8½	De.14, De.31	0.50
Nevada Consol.	New York	13½	12⅝	13	Sept. '20, Q	0.25
New Cornelia	Boston	17⅞	17	17	Au.3, Au.20, Q	0.25
New Dominion	N. Y. Curb	2⅛	2	2⅛		
North Butte	Boston	3	2⅜	2 1/16	Oct. '18, Q	0.25
Ohio Copper	N. Y. Curb	*77	*72	*75		
Old Dominion	Boston	16	15½	16	Dec. '18, Q	1.00
Osceola	Boston			31½	June '23, Q	1.00
Phelps Dodge	Open Mar.	†138	†133		De.20, Ja.2 Q	1.00
Quincy	Boston	21	19	20⅛	Mar. '20, Q	1.00
Ray Consolidated	New York	11⅛	10⅞	10⅞	Dec. '20, Q	0.25
Ray Hercules	N. Y. Curb	*24	*20	*24		
St. Mary's Min. Ld.	Boston	*32	*31½	*31½	No.9,De.11,K	1.00
Seneca Copper	New York	5⅜	5	5⅛		
Shannon	Boston	*49	*35	*40	Nov. '17, Q	0.25
Shattuck Arizona	New York	6½	6	6	Jan. '20, Q	0.25
South Lake	Boston			¼		
Superior & Boston	Boston	*90	*80	*85		
Tenn. C. & C. cfs.	New York	9⅞	8⅞	9	De.31, Ja.15, Q	0.25
Tuolumne	Boston	*50	*20	*45	May '13,	0.10
United Verde Ex.	N. Y. Curb	27	26½	26½	Ja.1, Fe. 1, Q	1.00
Utah Consol.	Boston			*1	Sept. '18,	0.25
Utah Copper	New York	65⅛	64⅝	65⅛	De.3, De.15, Q	1.00
Utah Metal & T.	Boston	*35	*33	*35	Dec. '17,	0.30
Victoria	Boston	*75	*75	*75		
Walker Mining	N. Y. Curb	3½	3	3		
Winona	Boston	*25	*13	*25		
Wolverine	Boston			5¾		
NICKEL-COPPER						
Internat. Nickel	New York	14½	13⅞	14	Mar. '19,	0.50
Internat. Nickel pfd.	New York	80	80	80	Ja.17, Fe.1, Q	1.50
LEAD						
Carnegie Lead & Zinc	Pittsburgh	3½	2⅝	2⅝		
National Lead	New York	149½	144	146⅜	Fe.21,Mh.15, Q	1.75
National Lead pfd.	New York	113½	112⅞	113	No. 23, De. 15	1.75
St. Joseph Lead	New York	23	22¾	23	De.9, De.20	0.50
ZINC						
Am. Z. L. & S.	New York	9	8½	8⅞	May '20	1.00
Am. Z. L. & S. pfd.	New York	30⅝	30⅛	30½	Nov. '20, Q	1.50
Butte C. & Z.	New York	5⅜	5⅛	5⅛	Ma., '23,	0.50
Butte & Superior	New York	19⅛	17⅞	17⅛	Je.15, Je. 30, Q	0.50
Callahan Zn-Ld.	New York	5⅛	5	5	Dec. '20, Q	0.50
New Jersey Zn.	N. Y. Curb			151½	Ja.31, Fe.9	2.00
United Zinc	N. Y. Curb			*25		
Yellow Pine	Los Angeles	80	80	80	Dec. '23	0.03
SILVER						
Alvarado	N. Y. Curb			1½		
Batopilas Mining	New York	⅛	⅛	⅛	Dec. '07, I	0.12
Beaver Consol.	Toronto	*29⅛	*27⅛	*28⅛	May '20, K	0.03
Castle-Trethewey	Toronto	*63	*62	*62½		
Coniagas	Toronto	2.30	2.20	2.30	Oc.19,No.1,'23	0.02½
Crown Reserve	Toronto	*69	*65	*65	Jan. 17,	0.05
Kerr Lake	N. Y. Curb	2	2	2	Oc. 1, Oc. 15, Q	0.12½
La Rose	Toronto	*24	*23	*23	Apr. '22,	0.10
McKinley-Dar.-Sav.	Toronto	*14	*12¾	*13¾	Oct. '20, Q	0.03
Mining Corp. Can.	Toronto	3.88	3.78	3.79	Sept. '20, Q	0.12½
Nipissing	N. Y. Curb	6¼	6¼	6¼	Ja.1, Ja.21, QX	0.30
Ontario Silver	New York			7⅛	Jan. '19, Q	0.50
Temiskaming	Toronto	*32	*31½	*32	Jan. '20, K	0.40

Stock	Exch.	High	Low	Last		Last Div.
GOLD						
Alaska Gold	New York	⅛	⅛	⅛		
Alaska Juneau	New York	1	1	1		
Carson Hill	Boston	2⅜	2⅛	2⅛		
Cresson Consol. G	N. Y. Curb	4⅛	3⅞	4⅛	De.31, Ja.10,Q	0.10
Dome Mines	New York	17⅞	17⅝	17⅞	De.31, Ja.2, Q	0.50
Golden Cycle	Colo. Springs	1.28	1.25	1.28	De. '22, Q	0.02
Hollinger Consol.	Toronto	12.25	12.00	12.00	Fe.7, Fe.25, M	0.05
Homestake Mining	New York	55½	55	55	Fe.20,Fe.25, M	0.50
Kirkland Lake	Toronto	*22	*21⅛	*21⅛		
Lake Shore	Toronto	†3.61	†3.57	3.62	Fe.2, Fe.15, Q	0.02
McIntyre-Porcupine	New York	18	17⅞	17⅞	De. 1, Ja. 2,	0.25
Portland	Colo. Springs	*40	*40	*40	Oct. '20, Q	0.01
Teck-Hughes	N. Y. Curb	1 5/16	1⅛	1⅛		
Tom Reed	Los Angeles	*43	*43	*45	Dec. '19,	0.02
United Eastern	N. Y. Curb	1⅛	*95	*97	Ja.8, Ja.28, Q	0.15
Vipond Cons.	Toronto	†1.31	†1.29	1.33		
Wright-Hargreaves	Toronto	3.00	2.90	2.90	Se.15, Oc.1, Q	0.02
Yukon Gold	N. Y. Curb	*74	*74	*74	June '18,	0.02½
GOLD AND SILVER						
Boston-Mont. Corp.	N. Y. Curb	*17	*16	*17		
Con. Cortez	N. Y. Curb	*66	*63	*66		
Con. Virginia	San Francisco	7⅛	6	7⅛		
Continental Mines	N. Y. Curb			4		
Dolores Esperanza	N. Y. Curb	*70	*60	*70	Jy. 1, Jy. 10 Q	0.05
Jib Consol	N. Y. Curb			*25		
Premier Gold	N. Y. Curb			2⅛		
Tonopah Belmont	N. Y. Curb	*75	*68	*70	Apr. '23, Q	0.05
Tonopah Divide	N. Y. Curb	*39	*38	*39	Se.22, Oc. 10	0.10
Tonopah Extension	N. Y. Curb	2 5/16	2	2 3/16	Dec. 11, Ja. 1	0.05
Tonopah Mining	N. Y. Curb	1 11/16	1 11/16	1 11/16	Se.30, Oc. 1	0.07½
Unity Gold	N. Y. Curb	1 5/16	1⅛	1 5/16		
West End Consol.	N. Y. Curb	*78	*71	*73	Mar. '23, Q	0.05
SILVER-LEAD						
Ahumada	Boston Curb	6½	6½	6½	De.15, Ja.2, X	0.10
Bingham Mines	Boston	17	16½	17	Sept. 19, Q	0.25
Cardiff M. & M.	Salt Lake			86	Dec. '20,	0.15
Chief Consol.	Boston Curb	4⅛	4⅛	4⅛	Ja 11, Fe.1, Q	0.10
Columbus Rexall	Salt Lake	*30	*29	*30	Aug. '22	0.03
Consol. M. & S.	Montreal	38½	36½	36½	Oct. '20, Q	0.62½
Erupcion	Boston Curb	2⅛	2⅛	2⅛	De. 15, Ja. 2, X	0.125
Federal M. & S.	New York			11½	Jan., '09	1.50
Federal M. & S. pfd.	New York	45½	43½	43½	No.26, De.15,	1.75
Florence Silver	Spokane	*23½	*22	*23½	Apr. '19, QX	0.01
Hecla Mining	N. Y. Curb	9⅛	8⅞	8⅞	No.15, De.15	0.25
Indian Mines	N. Y. Curb			*64		
Iron Blossom Con.	N. Y. Curb			*32	Oct. 26, '23,	0.02
Marsh Mines	N. Y. Curb			*13	June '21, I	0.02½
Park City	Salt Lake	4.75	4.75	4.75	Jan. 24,	0.15
Park Utah	N. Y. Curb			4⅛	De.8, Ja.2, Q	0.15
Prince Consol.	Salt Lake			*75	Nov. '17,	0.02
Silversmith	Spokane	*32½	*32	*32	Oc. 1, Oc. 10	0.01
Simon Silver-Lead	N. Y. Curb			*1		
Tamarack-Custer	Spokane	1.35	1.35	1.35	Se.30, Oc. 1, K	0.02
Tintic Standard	Salt Lake	3.97½	3.95	3.95	Ja. 5, X	0.25
Utah-Apex	Boston	3	2⅞	3	June '23, QX	0.50
IRON						
Bethlehem Steel	New York	62⅛	59½	61	Mh. 1, Ap. 1, Q	1.25
Char. Iron	Detroit	1½	1½	1½		
Char. Iron pfd.	Detroit	2	2	2		
Colorado Fuel & Iron	New York	29⅛	26⅞	28	Fe.11, Fe.25 Q	2.00
Col. Fuel & Iron pfd.	New York			102	Feb. '23, Q	2.00
Gt. North'n Iron Ore	New York	31½	29⅞	30⅛	De.10, De.27	2.00
Inland Steel	N. Y. Curb			46	Mh.15, Apl. 1 Q	0.62½
Mesabi Iron	N. Y. Curb			5		
Replogle Steel	New York	13⅜	12½	12⅝		
Republic I. & S.	New York	61½	58½	60⅜	May '21	1.50
Republic I. & S. pfd.	New York	94	93⅜	93⅜	Mh.20,Ap.1QX	2.75
Sloss-Sheffield S.&I.	New York	67⅜	63½	66	Feb. '21,	1.50
Sloss-Shef. S.&I.pfd.	New York	86½	86½	86½	De.20, Ja.2, Q	1.75
U. S. Steel	New York	109	106⅝	108⅛	Mh. 29, QX	1.75
U. S. Steel pfd.	New York	120	119	119⅛	Mh.29, Q	1.75
Virginia I. C. & C.	New York			49	De.15, Ja. 2	1.50
Virginia I.C.&C.pfd.	New York			80	De.15, Ja.22	2.50
VANADIUM						
Vanadium Corp.	New York	32¾	31	32½	Jan. '21, Q	1.00
ASBESTOS						
Asbestos Corp.	Montreal			30	Se.29, Oc.15 Q	1.00
Asbestos Corp. pfd.	Montreal			59¾	Se.29, Oc.15, Q	1.50
SULPHUR						
Freeport Texas	New York	11⅛	9⅛	10⅜	Nov. '19, Q	1.00
Texas Gulf	New York	64½	63	64	De.1,De.15QX	2.00
PLATINUM						
So. Am. Gold & P.	N. Y. Curb	3⅜	3⅜	3⅜		
MINING, SMELTING AND REFINING						
Amer. Metal	New York	44⅜	43⅛	43⅛	Fe.18, Mh.1, Q	0.75
Amer. Metal pfd.	New York			108⅛	Fe.20,Mh.1, Q	1.75
Amer. Sm. & Ref.	New York	61⅜	59⅛	61⅛	Ja. 11, Fe. 1, Q	1.25
Amer.Sm.&Ref.pfd.	New York	100⅛	98⅛	99	Fe.20, Mh.1,	1.75
U. S. Sm. R. & M.	New York	21	20⅜	20⅜	Jan. '21, Q	0.50
U.S. Sm. R.&M.pfd.	New York	39⅜	39⅛	39⅜	Ja.7, Ja.15 Q	0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. K, Irregular. I, Initial, X, Includes extra.

Toronto quotations courtesy Arthur E. Moysey; Spokane, Pohlman Investment Co.; Salt Lake, Stock and Mining Exchange; Los Angeles, Chamber of Mines and Oil; Colorado Springs, Colorado Springs Stock Exchange.